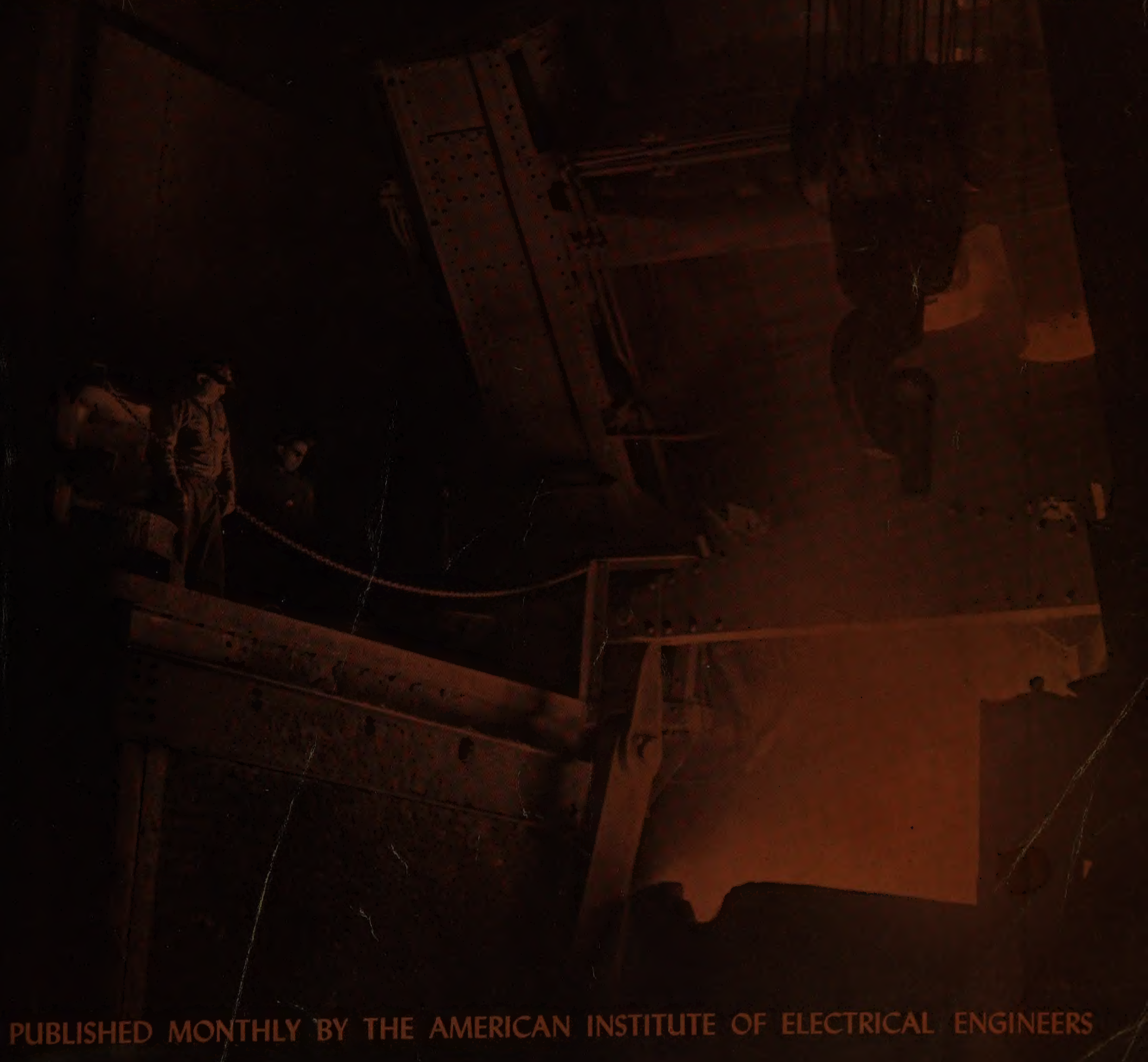
ELECTRICAL ENGINEERING

SEPTEMBER 1944



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VOLUME 63, NUMBER 9
SEPTEMBER 1944

The First 60 Years of the AIEE

NEVIN E. FUNK
FELLOW AIEE

The modest beginnings of the Institute in 1884 at the time of the international electrical exhibition in Philadelphia, Pa., and its growth and expansion into a professional organization of international standing are described in this article. AIEE's contributions to the war effort also are recounted.

THE INSTITUTE'S 60th birthday was the 13th of May 1944. The first 50 years of our history have been presented in the golden-anniversary number of *Electrical Engineering*;[1] in it most of the then living past presidents individually covered some specific part of the many activities of the Institute in a comprehensive way. I will not attempt to duplicate that information.

A few days after the Institute's birthday had passed, the 100th anniversary of sending the first electric-telegraph message was celebrated. The telegraph industry was 40 years old and a well-established going business when the Institute came into being. It is not at all surprising that the list of names of the 25 men issuing the call for the organization meeting contained 21 telegraph men and only four representing other industries.

The urge to establish a national electrical society in the United States was precipitated by the arrangements which had been made by the Franklin Institute to hold an international electrical exhibition in the city of Philadelphia during September and October 1884; the electrical men in the United States thought it would be a lasting disgrace to Americans if there were no official national electrical organization to welcome the foreign dignitaries who came to visit this exposition.

The Institute was formally organized on May 13, 1884, and Norvin Green, then president of the Western Union Telegraph Company, was elected its first president. Norvin Green was born in New Albany, Ind., in 1818, but spent his early life and received his education in Kentucky, beginning his business career as a physician. Doctor Green, however, became interested in politics and was elected for a number of years as member of the Kentucky legislature. In 1853 he was appointed Commissioner of the United States in charge of the construction of national buildings in Louisville. It was while he was engaged in these duties that he became interested in the United Morse and People's Telegraph Lines between Louisville and New Orleans. There were many small independent telegraph companies in those days, and Doctor Green believed that they should be consolidated into companies which could give universal telegraph service. He was the first president of the Southwestern Telegraph Company, which combined the telegraph lines between New Orleans and Louisville. In 1886, when the America, the United States, and the Western Union companies were consolidated into the Western Union Telegraph Company, Doctor Green was chosen vice-president and held this office until 1878 with the exception of three years, during which he was president of the Louisville, Cincinnati, and Lexington Railroad Company. He was elected president of the Western Union Telegraph Company in 1878, and held that office until his death in 1893 at the age of 75. Doctor Green was an ardent worker for the establishment of the Institute, and his foresight and optimism were very helpful in the early days of its existence. He was one of the four men to serve two successive years as president of the Institute.

Although the Institute was founded primarily by men of the telegraph industry, almost immediately its work was dominated by the men of other rapidly growing branches of electrical activity. For the first 15 years of its life, of the papers and discussions presented, only three per cent pertained to the telegraph industry; 80 per cent referred to a-c practice and theory, traction, motors, dynamos, prime movers, electric transmission, lighting, fundamental units and Standards; and a scattering was devoted to specialties like the production of aluminum, welding, and therapeutics. The rapid growth of other interests than that of telegraphy also is indicated by the fact that of the first ten presidents only two were connected with the telegraph industry, although that industry had been in operation for 40 years.

When Norvin Green was elected to the presidency for the first time he was 64 years old, and was one of only three presidents during the next 30 years who were over 47 years of age. The reason for this, of course, was that the expanding young industry was being operated by young men. The average age of the presidents when elected to office during the first two decades of the Institute's history was 42 years, as compared to 56 years for the last two decades, and is again indicative of the fact that the beginning of the present electrical industry was almost wholly in the hands of young men.

From its very earliest beginning, the Institute has presented a forum for the expression of individual opinions and the discussion of electrotechnical subjects. It was this opportunity for exchanging ideas and the work done by the various committees which aided in the rapid progress that took place in the early beginnings of the industry and which has so greatly affected almost every activity in our lines.

One of the earliest committees, units and Standards, later changed to the present Standards committee, shows that the founders of the Institute appreciated the necessity of establishing Standards early in the life of the industry. One can well understand the chaos which would have resulted if there had been no guiding hand and each manufacturing establishment or user had followed his own inclinations. Standards were established for the performance of various types of apparatus having to do with efficiency, temperature rises, types of insulation, rating, regulation, classification of voltages and frequencies, overload capacities.

The co-operative manner of establishing these Standards was such that progress was not impeded in the very rapidly advancing technique of the electrical industry, and it is hard to conceive how this progress could have been accomplished other than through the office of the Institute committees.

The work of the Institute was not confined alone to physical Standards, but was carried further into the standardization of abbreviations and the development of standard definitions of electrical terms

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Essential substance of an address delivered at the 60th anniversary commemoration held during the AIEE North Eastern District technical meeting, Boston, Mass., April 19–20, 1944.

Nevin E. Funk, president of the Institute at the time this address was made, is vice-president in charge of engineering of the Philadelphia Electric Company, Philadelphia, Pa.

which facilitated the correct communication of ideas. Neither were the Institute's activities confined to committee work wholly within the Institute organization; very shortly after the turn of the century representatives were appointed to joint committees with other technical organizations both in America and abroad, thus giving the Institute an international standing.

The opportunity to discuss openly scientific problems has promoted the intellectual development of all the members of the Institute and broadened their opportunities for increased knowledge at a much greater pace than otherwise would have been possible. Books written by individuals usually contain only the author's ideas or his interpretation of the thoughts of others, and the length of time required for preparation always makes publication materially behind the performance of industry. The publications of the Institute, however, present information following closely on the heels of performance and are able to offer many different approaches to problems pressing for solution, because of the opportunity furnished for many individuals to express themselves. In the works of the Institute we are always able to lay our hands on up-to-date sharpened mental tools with which to approach our tasks.

During the Institute's lifetime, of course, many committees have been formed and later passed out of existence when the need for them disappeared. However, the number of committees has grown from a mere handful in the 1880's to 43 in 1934 and 55 today. Our representation in joint efforts with other organizations, which did not begin until after 1900, grew with extreme rapidity until we had representatives on some 33 organizations in 1934, which has been expanded to 37 today.

The growth in membership of the Institute led in 1893 to the consideration of the desirability of holding meetings in some of the other large cities, besides New York, and a plan was adopted in November of that year providing for holding local meetings in any city upon the petition of 20 members. Subsequently, monthly meetings were held in Chicago, usually on the same evenings as the meetings in New York. So that in 1893 we find in effect that the Institute had one local Section, although it was not known as such.

In 1902, the board of directors approved the organization of local groups known as Sections and Branches, and the number of Sections grew with great rapidity. By 1934 we had 61 local Sections and 113 Student Branches. Today we have increased our local Sections to 73 and our Student Branches to 125. In membership we grew from an initial 71 in 1884 to over 18,000 by 1927. As a result of the depression this number had dropped down to 15,000 in 1934, but has increased so that today it is over 22,000. This expansion in membership which continued at an ever-increasing rate without any reversal in trend from the date of organization until 1927 is in itself a positive indication of the marked influence which the Institute has had in both the industrial and educational fields.

AIEE CONTRIBUTIONS TO WAR EFFORT

War activities are foremost in our minds today, and the contributions which the Institute has made are not so generally known as they might be. We did not wait until after Pearl Harbor to begin these activities. On June 27, 1940, the board of directors adopted a resolution to offer the services of the Institute to the President of the United States in connection with any problems of national defense in which they might be of aid. In January of the next year the committee on air transportation notified the Army–Navy Aeronautical Board that it was in a position to be of aid in connection with the development and co-ordination of aeronautical electric equipment. At the same time the Institute committee on national defense was appointed with Comfort A. Adams as chairman, and John C. Parker was designated as the Institute's representative on the National Technological Civil Protection Committee appointed by the Secretary of War. The Institute also organized a civil protection committee in 1941, with Doctor Parker as chairman, and appointed five representatives on the Engineers Defense Board, which consisted of representatives from six different engineering societies. This board completed certain studies on critical materials and was dissolved in 1942.

In the same year, the committee on national defense and the civil protection committee were combined to form the committee on co-operation with war agencies. At this period the Armed Forces were searching for technical specialists of many types who would be able to meet the requirements for commissions in the services, and this new committee, with the assistance of the Institute Sections, submitted more than 600 names from which many highly qualified officers were secured. This committee also appointed three subcommittees for specific activities; one engaged in a comprehensive collection and distribution of information on the conservation of critical materials; another assisted the Signal Corps in the establishment of a technical reference library; and the third acted in an advisory capacity on the allocation of technical man power.

The Institute also appointed a special committee to co-operate with representatives of the conservation division of the War Production Board on the substitution of silver for copper and aluminum in electrical installations. This committee was able to report very specific recommendations regarding some substitutions which were feasible.

The Standards committee carefully considered the many technical problems involved in the preparation and use of war emergency electrical Standards. It concluded that in a great majority of cases wartime requirements could be met effectively by the preparation of wartime guides and interim reports covering the application of various types of standard electric apparatus under emergency conditions.

Therefore, the Standards committee, in collaboration with the technical program committee and the committee on co-operation with war agencies, recommended that the Institute's technical committees prepare guides and reports covering the economical application and operation of electric apparatus under these conditions, and that wherever necessary emergency substitutions or modifications of present Standards be developed.

Many of these guides have been completed. They are educational in character and are in no way mandatory. They are intended to make essential information immediately available to war industries, thus furthering conservation of critical materials and labor, and they cover many types of equipment, including shunt capacitors, power cables, circuit breakers and switchgear, generating equipment and systems, system-grounding impedance, industrial power-distribution systems, electric motors and controllers, automatic-reclosing equipment on stub feeders, power transformers and regulators, distribution transformers, current-limiting reactors, lightning arresters, conductors for supervisory control and telemetering, and out-of-step relay protection.

There was an immediate need for a modification of one existing Standard, 45, "Recommended Practice for Electrical Installations on Shipboard," and it was produced by the committee on marine transportation under the title, "Modification of and Supplement to AIEE Standard 45." It is to apply during the emergency only.

Since the fundamental objective of the Institute is the advancement of the theory and practice of electrical engineering, the technical papers and the electrical Standards produced in peacetime are even more useful in wartime when new ideas must be used to the maximum extent. To increase its contributions in these fields the Institute has put major emphasis upon activities closely related to the war effort, and technical papers, publications, and Section meetings are devoted to subjects closely related to this theme insofar as practicable. All committees are expected to conduct their work in accord with the spirit of this policy.

In addition to the requirement that insofar as practicable all technical papers accepted shall be closely related to the war effort, some 25 sessions and conferences of national and District meetings have been devoted to such topics as substitution of materials, defense lighting, electric equipment for military aircraft, emergency loading of transmission systems, distribution systems in wartime, problems of engineering education, and technical personnel in wartime.

Also, a great many of the Institute Sections have held meetings connected with various phases of the war effort, including a considerable number of production clinics, held in co-operation with the War Production Board and other engineering societies, which were intended to expedite production of war materials, and also meetings on conservation of critical materials.

The Institute is represented by its national treasurer, W. I. Slichter, on the Joint Committee on Inter-American Engineering Co-operation, which was organized in 1941 to study methods of increasing engineering co-operation among the countries of North and South America, and in particular to develop an interchange of technical publications and engineering standards. Professor Slichter is also chairman of the Institute's own committee on Inter-American engineering co-operation.

In August 1943 the board of directors authorized the appointment of a special committee to consider methods through which the Institute might be helpful to Chinese engineers. Vice-President C. R. Jones was appointed chairman. With the co-operation of the American section of the Chinese Institute of Engineers and the Office of War Information, the committee has arranged for the transmittal on microfilm to technical centers in China of about 1,000 pages selected from the 1943 *Transactions*, about 900 pages of electrical Standards, and about 100 pages from *Electrical World* for 1943; and for the transmittal in book form of copies of electrical engineers' handbooks and a few electrical textbooks.

The Institute prepared a series of six radio programs on the work of electrical engineers in defense problems, which were broadcast early in 1941. Several engineering societies co-operated in a series of 11 broadcasts beginning in July 1942, which supplied much information on the place of engineers in war work.

Over 2,000 Institute members are serving in our Armed Forces. Two members of the Institute board of directors are in the Navy: F. R. Maxwell, Jr., as a commander at United States Naval Air Station, Pensacola, Fla., and W. B. Morton as a lieutenant commander in the Philadelphia Navy Yard. Three members of the headquarters staff were called into the Armed Forces: G. Ross Henninger, editor, serving as a lieutenant colonel in the Air Service Command, Patterson Field, Ohio; W. R. MacDonald, Jr., assistant editor, first lieutenant in the Signal Corps Reserve, called into active service in January 1941, promoted to captain, later to major, and now released from active service; and John J. Anderson, Jr., of the Standards department, serving as an ensign in the Navy. Colonel Henninger had, for several months before entering the Army, assisted the Navy Department on a part-time basis in the organization of an editorial and publication review section.

Other members of the headquarters staff have assisted as fully as possible in connection with a great many requests of wide variety from the Armed Forces and divisions of Government. In particular, service has been rendered in the development of the electrical-engineering check list of the National Roster of Scientific and Specialized Personnel in the search for men qualified for many types of technical work, a compilation of census of engineering construction firms, the extension of subcontracting plans, and a study of supply of and demand for engineers and greater use of smaller war plants. Beginning in June 1943, the Institute has published a four-page quarterly AIEE *Bulletin* for members in the armed services and the merchant marine.

A great deal of information regarding war activities of the Institute, divisions of the Government, and other organizations has been published in *Electrical Engineering*, and special attention has been given to any types of information which would assist in securing electrical engineers qualified to meet the many needs for technical men in the Armed Forces and in other organizations.

REFERENCE

1. *Electrical Engineering* (50th-anniversary number), volume 53, May 1934.

The Future of Aeronautics

R. DIXON SPEAS

The general future of air transportation and the nature of problems that are of immediate and future concern in the design and operation of civil aircraft are foretold in this article by an airline executive.

MANY contradictory pictures of air transportation in the future have been painted which vary from rosy optimism to the darker shades of pessimism. Just what may be expected realistically during the first ten years of peace?

Air transportation may be divided for discussion into three categories: types of aircraft, routes to be flown, and magnitude of the industry. With reference to the first, civil transports of the next three or four years now are flying in military service. A military cargo plane originally designed for service on the airlines has been performing spectacular transoceanic flights in military service for months. Currently the airlines are operating the Douglas *DC*-4 in the military service as the *C*-54 and obtaining thousands of hours of transport operating experience. When the time comes to return this long-range transport to the civil task for which it was originally designed, the engineering information thus gained will give air passengers the ultimate in speedy long-distance air transportation for the immediate postwar era.

With the long-range airplanes such as the Constellation and *DC*-4, such schedules may be expected as Boston to Los Angeles between breakfast and dinner of the same day with 40 to 50 passengers carried in club-car luxury as soon as aircraft can be spared from their military transoceanic tasks in this war. A conversion period of approximately six months probably will be required for readying this equipment to its civil tasks.

So much for the more spectacular view of air transportation to come. With regard to the mechanical details of these aircraft, all are equipped with hydraulically controlled landing-gear-retracting mechanism, brakes, and landing flaps, which are the main functions requiring major auxiliary power transmission on present-day airplanes. For the next five to ten years there will be gradual improvement in the basic design features of transport airplanes, including increases in size, speed, and comfort from 50 to 100 passengers, 250 to 325 miles per hour cruising speed, and general improvement in luxuries provided. As

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Essential substance of an address presented at the Institute's 60th anniversary observance during the AIEE North Eastern District technical meeting, Boston, Mass., April 19–20, 1944.

R. Dixon Speas is assistant to vice-president in charge of engineering, American Airlines, Inc., New York, N. Y.

The author acknowledges the assistance of William Petrasek of American Airlines, Inc., in the preparation of material for this article.

for electrical versus hydraulic features of these aircraft, the answers will depend in a large measure upon the electrical and the hydraulic engineers.

The second phase of air transportation in the future concerns routes to be flown. At the present time airways all over the world are being operated by the domestic airlines of the United States as well as the international carriers. Domestic route mileages flown, however, have decreased somewhat as compared to prewar standards. As for the future, transport aircraft may be expected to operate under all atmospheric conditions which exist in this world from the 100-degree temperatures of the equator to the subzero temperatures of the arctic areas. The route advantages of flying the arctic areas will undoubtedly increase in time to come, with increased flight range of new equipment and the requirements for improved services between the continents becoming more pronounced. For the immediate future commercial air routes probably will not be directly over the poles. Many more airways may be expected over the arctic than over the antarctic area, and design criteria for operating equipment are therefore based on atmospheric conditions of the arctic. Operating altitudes of airliners have gradually increased to present-day limits of 15,000 to 20,000 feet. Further increases to 30,000 feet may be expected during the next ten years, so that operating accessories must be designed with corresponding pressures in mind.

Magnitude of air transportation will depend upon the utility which American industry and the public are able to find for air transportation as well as the degree to which air-transportation systems are able to provide desirable services. In general, a five-fold increase in the air transportation industry may be expected during the next ten years, with a fleet of over 1,000 transports in active commercial service by 1950.

Probably the most important electrical problem in aircraft today, power transmission, which refers to such operations as retraction of landing gear, manipulation of flap controls, application of brakes, and other such items, is of a competitive nature, having been met with hydraulic and mechanical solutions as well as electrical designs. The choice between electric, hydraulic, or mechanical transmission fundamentally must be decided upon factors of reliability, ease of maintenance, and weight. The major present-day and immediate-future transports utilize hydraulic and mechanical systems for practically all power transmission. The ingenuity of electrical engineers is now challenged to devise and develop electrical equipment of corresponding or improved reliability, ease of maintenance, and weight. Applications in this respect have been applied to aircraft in the past, and further applications of such electrical systems in military aircraft now are being witnessed. The airlines are studying closely the experience gained in these military aircraft. The fact that ground power transmission by electrical means has been so outstandingly satisfactory for industrial application with regard to flexibility, reliability, and economy, lends considerable support to the thought that corresponding developments can be made in applications to the aircraft field.

A second important problem which in some measure depends upon solution of the power-transmission problem concerns the actual electric system to be provided. Basically, the problem is whether medium-voltage direct current or medium-voltage alternating current should be used for the newer and larger transports of the future. Practical application of an a-c system on aircraft awaits the development of a suitable constant-speed device for holding generator speed constant under conditions of varying engine speed, that is, the airplane engine operates under normal cruising conditions at varying speeds. A direct-drive device, therefore, is not satisfactory for a-c generation of a constant frequency, and a completely satisfactory constant-speed drive of reasonable weight has not yet been developed. Here again in the choice of an electric system, the basic determining factors of reliability, ease of maintenance, and weight are of paramount importance. Current air-transport planes utilize 12- and 24-volt d-c systems for all primary electric power.

A definite trend in aircraft-battery design is at present providing higher and higher voltages in the interests of saving copper. In general, it can also be said that the importance of storage batteries is decreasing.

A third problem is one of cockpit lighting. One of the airlines' most pressing problems of today from the standpoint of cockpit engineering is lighting. The conflicting demands of adequate lighting of instruments and outside visibility requirements are all associated with problems of glare, reflections, and refractions as well as the illumination problems. Any lighting engineer searching for fertile fields where research and development are desperately needed will do well to study cockpit-lighting problems. For, despite many outstanding developments, the airlines are still seeking more satisfactory solutions.

The matter of power generators also merits careful consideration on every new airliner. Until recently practically all power generation was by engine-driven generators with substantial storage-battery capacity. The trend has been toward increased generator capacities with less dependence on storage batteries. In some of the larger installations auxiliary gasoline-powered generators units have been proposed, and thoughts have turned to the utilization of engine-exhaust waste heat. Further research and development are required to determine the best over-all power-generator arrangement to provide equipment for that purpose.

Service equipment for airliners in the form of food warmers, liquid heaters, and hot plates for cooking is becoming of increasing importance to the electrical engineer. At first glance the respective problems appear to be quite simple in view of the multitudinous previous applications of corresponding equipment. Aircraft requirements of low weight and ease of maintenance, however, have so complicated the problems that today almost all food preservation is done by means of vacuum-bottle equipment. An electrical engineer with a desire to develop applications of heating units to airline operation will find his efforts welcomed by airlines.

Until the present time utility has been the main governing factor in all electrical designs for passenger-compartment lighting. The decorative feature now has increased in importance so that further research and development in this regard are required. The decorative values in lighting can be much more widely utilized in improving the interior design features of transport aircraft.

The tremendous developments in the electrical field during this war will do much toward meeting the corresponding problems of civil air transport. All such developments are being closely followed. Other problems, however, demand that the airlines secure the most ingenious application of electrical-engineering principles to air transportation.

Photo courtesy Transcontinental and Western Airlines

The Lockheed Constellation

Arthur H. Kehoe—1943 Lamme Medalist

The Lamme Medal

S. B. WILLIAMS
MEMBER AIEE

The 16th presentation of the Lamme Medal was made at the recent AIEE summer technical meeting in St. Louis, Mo. The award was made "For pioneer work in the development of a-c networks and associated apparatus for power distribution."

MEDALS are awards for valor. Just as many of our young men who are fighting the enemy are decorated for brave deeds, so do we today honor a man for his courage—not for physical intrepidity but for mental daring.

Because we honor our scientific and engineering heroes only after the battle has been won and we are able to weigh the merits of the achievement dispassionately, we lack the emotion that accompanies a decoration on the field of battle.

That is unfortunate because a medal is awarded not only as a recognition for courage but also as a means for inspiring others to exert themselves beyond the line of duty. The awarding of a medal should not be regarded as the closing of the record on some splendid achievement so much as the opening of the gates of new imagination.

This profession of electrical engineering needs inspiration of this kind so badly. The opportunities are greater today than ever before because the problems are more numerous. Yet the romance that was ours when Mr. Lamme lived has been dulled. We must restore it if we are to attract to the profession the young men whose desire is to create.

Mr. Lamme must have had something of this nature in mind when in an article for the *Ohio State Engineer* on "The Electrical Engineer of Today" he opened with these words: "The engineer views hopefully the hitherto unattainable." And the AIEE when it accepted the trust under Mr. Lamme's will must have had a like thought when it put those words of Mr. Lamme on the obverse of the medal.

The Lamme Medal is awarded annually by the AIEE for "meritorious achievement in the development of electrical apparatus or machinery" and was made possible by a bequest in the will of the late Benjamin Garver Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died 20 years ago. This medal is made of gold, the obverse of which has been mentioned. The reverse represents Niagara, for the harnessing of which Mr. Lamme designed the great electric generators.

Like all medals, however, the value lies not in its intrinsic value but rather in the roll of those who have received it. For that reason I would like to read the names of those who have received the medal, and add the name of the latest recipient. It is a list that adds luster to the award.

1928 *Allan B. Field*—"For the mathematical and experimental investigation of eddy-current losses in large slot-wound conductors in electric machinery."

1929 *Rudolf E. Hellmund*—"For his contributions to the design and development of rotating electric machinery."

1930 *William J. Foster*—"For his contributions to the design of rotating a-c machinery."

1931 *Giuseppe Faccioli*—"For his contributions to the development and standardization of high-voltage oil-filled bushings, capacitors, lightning arresters, and numerous features in high-voltage transformers and power transmission."

1932 *Edward Weston*—"For his achievements in the development of electrical apparatus, especially in connection with precision measuring instruments."

1933 *L. B. Stillwell*—"For his distinguished career in connection with the design, installation, and operation of electric machinery and equipment."

1934 *Henry E. Warren*—"For his outstanding contributions to the development of electric clocks and means for controlling central-station frequencies."

1935 *Vannevar Bush*—"For his development of methods and devices for application of mathematical analysis to problems of electrical engineering."

1936 *Frank Conrad*—"For his pioneering and basic developments in the fields of electric metering and protective systems."

1937 *Robert E. Doherty*—"For his extension of the theory of a-c machinery, his skill in introducing that theory into practice, and his encouragement of young men to aspire to excellence in this field."

1938 *Marion A. Savage*—"For able and original work in the development and improvement of mechanical construction and the efficiency of large high-speed turbine alternators."

1939 *Norman W. Storer*—"For pioneering development and application of equipment for electric traction."

1940 *Comfort A. Adams*—"For his contributions to the theory and design of a-c machinery and his work in the field of electric welding."

Arthur H. Kehoe receiving the Lamme Medal from President Nevin E. Funk in the presence of H. R. Searing, who introduced the medalist

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S. B. Williams is editor of *Electrical World*, New York, N. Y., and chairman of the AIEE Lamme Medal committee.

1941 *Forrest E. Ricketts*—"For his contribution to the high reliability of power-supply systems, especially in the design of apparatus for selective relaying and circuit reclosure."

1942 *Joseph Slepian*—"For his contributions to the development of circuit-interrupting and current-rectifying apparatus."

1943 *Arthur H. Kehoe*—"For pioneer work in the development of a-c networks and associated apparatus for power distribution."

Career of the Medalist

H. R. SEARING

FELLOW AIEE

IN sorting and clarifying my impressions of Arthur Kehoe, I labor under a certain difficulty—I have been so close to him for over 30 years that I now have to change my focus in order to bring to you a proper picture of the engineer and the man.

From his birth in Vermont in 1889, through the years of his basic education there, culminating in his graduation with the degree of bachelor of science in electric engineering from the University of Vermont in 1911, which university, incidentally, last month conferred upon him the honorary degree of doctor of engineering, he breathed the well-known atmosphere of individualism of that rugged state. It is easy to understand how that environment and that early Vermont training would develop his outstanding trait, namely, a tenacity and persistence in seeking out and developing methods of improving the way things are done. Equipped with a keen engineering mind, without predispositions, he has been able to evaluate shrewdly the results of research and new developments, to visualize methods of practical application, even to design tools, apparatus, and equipment where necessary to bring about the final accomplishment. That is the basis of the success which is being recognized here today.

Shortly after graduating, he was employed in The United Electric Light and Power Company in New York, N. Y., as an engineering assistant. This was a relatively small company which distributed a-c service underground in the Borough of Manhattan. With characteristic boldness, energy, and perseverance he delved into all phases of the company's activities; small problems and large ones had his attention. As a result of his detailed study of performance, trends in metering were changed and radical changes were made in the design of substations and substation equipment, particularly the control apparatus.

At that time, the greatest supply of electricity in Manhattan was direct current distributed by the New York Edison Company. This was a supply of a great degree of dependability—indeed, the only supply adequate to the exacting standards of that densely populated city with its tall buildings. He learned that the New York Edison Company had a national reputation because of its exceptional record of service continuity. Fundamentally, this service was direct current from a network backed by storage batteries. "Why not a comparable a-c service?" asked Kehoe. Obviously, the product his own company had to sell—alternating current in its then stage of development—was not able to compete with New York Edison Company service on equal terms for the peculiar electrical requirements of the metropolitan market.

The question of a-c service from a network was not new, but analysis of the scope of the problem brought realization of the obstacles that had to be overcome. These obstacles were imposing: the system would need to be distinctly more economical than the d-c network system; the apparatus would need to perform as well as the long-tried and long-developed d-c apparatus; no complicated operational procedures to bolster the failures of design or construction could be tolerated. Moreover, the fundamental factor, how to apply alternating current to a network, was not known, and the specific apparatus that would be required had not been designed. To one who was not convinced that the conception could be worked out, the problem would have appeared too difficult to solve. But Kehoe not only was convinced it could be worked out but that it would have to be worked out to meet the electrical future of New York. He sensed the mounting costs in the extension of the d-c network system and also that the limitation of duct space and conductor size or cable temperature practically prohibited greater loads on the system. These realizations whetted his determination to conquer the problem and served to counteract the discouragements which came along, as they always do.

These are some of the utilization, engineering and design factors that had to be determined and resolved:

1. With one set of service mains for both light and power, how much variation of incandescent-lamp illumination, due to voltage changes, would be permissible?

2. The performance of high-voltage and low-voltage cables under fault conditions had to be determined, in order to design the proper cable and develop means of protecting it, always with a view to maximum reliability at minimum cost.

3. Changes in transformer design had to be made to assure the safe operation of a network fed in multiple from the secondaries of transformers, a number of transformers being connected to any one of several radial high-voltage feeders.

4. It was necessary to design and assemble a combination of fuses, circuit breakers, and relays that would respond automatically and in proper sequence to fault and operating conditions.

The first installation of the network system was placed in service in April 1922. It consisted of 29 switches, supplied from four high-voltage feeders. The then available transformers, relays, cables, circuit breakers, fuses, and other accessories were used. These, however, had been greatly modified in design to meet the demands of the new system. While many of the elements existed, it was Kehoe who engineered the modifications and combinations of the elements, and introduced other elements. In short, much adaptation of existing material and equipment was done at little expenditure of money. Success depended almost wholly on the foresight and imagination of the planner. By his broad conception and practical mind, the automatic a-c network was brought into being. The story of the initial installation and the early operating results was given to the profession by Kehoe at a meeting of this Institute at Chicago in June 1924. Moreover, Kehoe in this paper predicted that a-c network distribution would have profound effects upon generating-station and system design. You who are familiar with such matters know how rapidly this prediction has been fulfilled. Today, the low-voltage network system, as started in 1922, is used in at least 165 communities. The peak load serviced by low-voltage networks in 1943 was approximately 2,125,000 kw. The total installed transformer capacity was over 4,600,000 kva.

Reference could be made to the patents issued to Mr. Kehoe, to the technical papers he has contributed, to his active participation in civic affairs, and to his help in the establishment of sound educational work in engineering. I might refer, also, to some things in which he has failed—notably in his effort to identify golf balls with his initials because he has not succeeded in placing the initials on the ball in such a manner as not to unbalance the ball.

All of this would not suffice to describe the outstanding worth of the man. In all his work he has been modest, has shunned the spotlight. His method has been to foster the development of others by providing them with the opportunity to demonstrate their abilities. He would pose the problem, he would suggest possible solutions, he would give the man his head, he would be a constant source of encouragement and inspiration to the one striving honestly for a result.

Many young engineers, and some others now grown both in years and wisdom, would join me, I am certain, in being thankful that we had the benefit of this man's guidance.

H. R. Searing is executive vice-president, Consolidated Edison Company of New York, Inc., New York, N. Y.

We believe that Benjamin E. Lamme, the donor of the medal, would look with favor on the committee who selected Arthur H. Kehoe to be the recipient of the medal, and we who have known him for years are elated to have his name added to the list of those illustrious men on whom the medal previously has been bestowed.

Story of the A-C Network

ARTHUR H. KEHOE
FELLOW AIEE

It is doubtful if a reasonably complete story of the contributions which a select group of men made at considerable risk during the development of successful multiple-feed a-c network distribution has ever been compiled. I feel I owe it to them to start one, since their work, which has had scant recognition, caused mine to be noted.

My tale, like many pertaining to the practice of electrical engineering up to this time, has its root in the character of, and the struggles with, insulation that is to be found in practice. At some future date, perhaps in this next decade, engineers may wonder why any of the contributions which I will discuss were ever considered important. When they can take such a view, insulation and also the practice of electrical engineering will have changed for the better.

Early in this century, on Manhattan Island south of 135th Street, the great New York Edison Company d-c distribution system had a small competitor using underground a-c distribution. The Edison Company was the premier system for almost any complimentary characterization one might wish to make and its service was so excellent that many in New York were unaware that there was any other service. While a giant–pigmy situation existed, nevertheless the little United Electric Light and Power Company system was by far the largest underground a-c distribution system in the United States since at that time most a-c systems consisted of a minimum of underground cable and a maximum of overhead lines. Although we were not the only system having insulation failures, we had a concentration that was not experienced elsewhere.

Our system used radial underground circuits of the three-kilovolt class. Distribution transformers were air cooled and located in vaults on consumers' premises, and had their secondaries connected to low-voltage cables in the streets. Each circuit from a substation had a few principal branches, which in turn supplied a number of the transformers that were joined in a network by the street mains in the area fed by that branch. These distribution circuits were highly developed in order to locate faults promptly and eliminate their effects.

Failures provided a hectic existence and it did not take genius of a high order to suggest that interruptions would be minimized if all the small radial networks on a number of circuits were interconnected and each transformer secondary was provided with a reverse-trip switch to open when a fault occurred on the circuit feeding its transformer. This arrangement was proposed in 1912. At the time suitable circuit breakers were unknown, except possibly those in the form of motor-starting contactors, and existing reverse-energy relays were too expensive to put at every transformer. Furthermore, there were serious reservations as to supervision of automatic equipment on so many consumers premises, both due to costs and to limited accessibility. The alternative of using switches that were fully automatic was intriguing but required development of a new and radical type of equipment for that day. The answer, of course, was to continue the accepted practice: use automatic double-throw switches on the more-important installations, while continuing distribution-transformer fuse-blowing network protection of the McCoy and Sprong type, as well as making better installations and better fault-hunting conditions.

In 1913, G. E. Palmer, a manufacturer of Boston, had produced a circuit breaker for remote electrical operation which encouraged a review of the 1912 proposal. When the requirements were explained, he promptly produced a satisfactory switch. For a time following the delivery of this Palmer circuit breaker, he accepted our conclusion that we in New York were the relay experts. Soon he surmised in his keen way how little more we knew than he did of relaying and then began spending time and money for the entire development. By 1916, H. R. Searing and W. R. Bullard, along with some of our laboratory staff, were working on network equipment and also on types of combined service for both lighting and polyphase motors. At this date it was generally agreed by those interested that there would be required for a successful installation a full-automatic network switch which would open on a reversal of energy as small as the magnetization value of its transformer and would close only when circuit conditions were such that the transformer would supply load when connected to the secondary network. The phasing circuit across the open switch, having in series a variable resistance in the form of tungsten lamps, was settled upon and has had extensive use ever since. However, the reverse-energy feature, which numerous calculations indicated to be possible as designed, did not emerge from the laboratory as being within operating limits although many variations were tried. All types of current transformers or shunts with different relays were reported as failures either at transformer-magnetization values or at full load including the momentary short-circuit values of 10 to 20 times transformer full load. The principle of a saturating circuit for protective relays, previously developed by F. E. Ricketts of Baltimore, the Lamme Medalist of 1941, was applied in these various attempts without satisfactory results. No one up to that time was known to have produced a metering or relay circuit with such an extended range of operating values as was needed for the network switch.

Meanwhile, World War I threatened, and finally broke on us. The industry experienced rapidly increasing demands for electric service, the desirability for a uniform service throughout the United States, a shortage of materials, and a scarcity of money to make the necessary expansion which was combined with rising prices and reduced return under our fixed rates. Such happenings brought the first rumblings of change in d-c systems throughout the country. Before the end of the war in 1918, Lamme had presented a paper before the Institute on the "battle of the frequencies." It was an excellent sample of postwar planning for 60 cycles. The period immediately following the war brought to the fore subjects such as elimination of standby storage batteries in d-c substations, restriction of d-c

The Lamme Medal, established in 1926

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growth, and cutting over d-c loads to alternating currents. Such questions resulted in engineering discussions on d-c substations to be started from a-c sources, a-c starting of rotary converters versus the use of motor generators, and the frequency of the supply for future d-c loads.

The discussion arising concerning d-c systems of the time also brought forth many suggestions for changes in a-c systems. As a result, pioneering occurred in many places with end results which, while not uniform, provided the structure with which the electrical industry has been able to meet all the vast and varied demands of this present world struggle. Distribution took the following course: Philadelphia, first with W. C. Eglin and later P. H. Chase; Brooklyn with J. C. Parker and H. R. Woodrow; New Orleans and other Electric Bond and Share Company companies with A. E. Silver; and a number of midwestern and Pacific Coast cities, particularly Seattle, were all strong proponents for radical change from the established d-c system and so their spokesmen were leaders in suggesting improvements in a-c service. Of course the forum of discussion was a restricted one as the use of direct current was generally limited to the densely loaded city areas and d-c service was excellent for those days except as to the matter of costs.

Meanwhile the United Company in New York was developing a strong group of men who later contributed so much to developments. Searing, returning with valuable war experience, produced the closest approach to a successful network relay to operate a Palmer-type switch. This was a Kelvin-balance-type relay to obtain an extended range with an "over the hump" type of operation. Bullard, followed shortly by C. W. Franklin, G. R. Milne, J. E. B. Stuart, and E. R. Thomas, took up the many problems in detail and resolved them one by one, producing solutions that have stood the test of time. At this time Seattle, facing a problem of developing *de novo* a city district, wanted to get proper results with a system which would show reduced costs compared to extending their d-c system. The experimentation proceeding in New York had come to their notice, and in 1920 M. T. Crawford rechecked but found the apparatus development not yet satisfactory for full-automatic switching. Seattle then in 1921 made the famous pioneer installation of a multiple-feed a-c network with manually closed switches at each transformer secondary which would open on reverse energy in case of fault on any of the primary apparatus on the circuit to which the transformer was connected.

While the Seattle installation was in the construction stage a turn of fortune brought across my desk two reports almost simultaneously, containing full technical data on certain new designs of metering equipment. One was a new watt-hour meter for installation on consumer's service, the other was a current transformer for high-voltage metering. With these data, only one evening's work was required to design a multiturn shunt utilizing the iron stampings of the current transformer to which was solidly connected, without intervening "jim-cracks" of any kind, the new watt-hour meter, minus its register. This equipment, built to detailed dimensions by our shop, when delivered to the laboratory and connected with a five kilovolt-ampere transformer gave so much pep on reverse-energy magnetization of the transformer that confidence in my technical training came back to me. Of course the laboratory was unable to determine by direct instrument readings just what was occurring but they did demonstrate that both full-load and short-circuit current values for a 50-kva transformer could be handled satisfactorily with this same relay–shunt combination. Thus a single relaying element had been produced which would handle a 5- or a 50-kva transformer which was our entire range of distribution transformers at the time on radial networks. That was the high-water mark of my career so far as it concerned work on "development of electrical apparatus."

Everything moved rapidly from that time. In a few days simplified shunts, of a type which previously had been reported inadequate, were available for the various sizes of transformers. Meter parts were used for relays. While some of these refinements took place in New York, much of the work was accomplished by G. E. Palmer in Boston. He, more than anyone else, had been responsible for the original proposals being reduced to practice.

Conditions necessary for a successful a-c network to render reliable service at less cost than d-c distribution had been produced at long last and the trial installation with Palmer equipment went into service on Thursday, April 12, 1922.

The Seattle nonautomatic and the New York automatic a-c networks were installations which obtained high reliability of service at reduced cost compared to a competitive d-c system in each case. Shortly after this, Philadelphia, under Chase's guidance, installed a network of somewhat different design to obtain a-c reliability which also has been successful. Those installations succeeded in eliminating the insulation-failure problem so far as reliable a-c distribution service was concerned. Of greater significance, however, they also signaled the start of a harvest of benefits since the change from a-c radial to a-c network distribution affected other elements than the basic one of reliability of service.

The extensive development of such networks after 1922 came about because of reduced costs that are obtained with high-voltage distribution at generated voltage since this arrangement eliminates the usual step-down substation. The production by the electrical manufacturers of suitable distribution transformers made high-voltage distribution practicable. The problem of a universal service on alternating current which was not so simple as it had been with direct current then became a national one with lamp and motor voltages, type of polyphase motors, and metering methods all up for review in many places. It was at this stage that our Manhattan group of Searing, Franklin, Milne, Stuart, and Thomas made full use of years of study that they had given such problems. Bullard, having joined the Electric Bond and Share group of companies under Silver first at New Orleans and then at a number of other cities, and Parker and Woodrow in Brooklyn were all active in the pursuit of reduced costs which were to be realized with high-voltage primaries for network distribution. Each of these men exerted a strong influence in the final stages and out of network developments which were undertaken for economy in a number of cities in rapid succession the three-phase four-wire secondary service emerged as the one generally to be adopted.

I have mentioned only the men whom I know from personal contact to have made outstanding contributions to the end results, and of course have been obliged to omit many names that come to mind. However, I feel that this review today would be very incomplete if I did not list the pioneer work of Fred Hanker, Westinghouse Electric and Manufacturing Company, and Harry Summerhayes, General Electric Company. Both of them, had wonderful insight and expert knowledge relative to the distribution problems of their period. Each contributed in a large measure to orderly progress, particularly in arriving at practicable compromises where the three-phase four-wire service was adopted. I believe that their foresight eliminated numerous difficulties which easily might have occurred in the pioneer installations, particularly in the early use of the combined light and power service. They earned many times over their recognized position of being the wise counselors of utility distribution engineers.

The Westinghouse Company, first of the large manufacturers to enter this equipment field, delivered for the 1924 installation in New York the first automatic network switches that they made. They previously had supplied Seattle with nonautomatic units. The first network papers before this Institute were presented at Chicago, about a fortnight before Lamme's passing on July 8, 1924. I like to think that he was interested in this development as he was in most every other advance in electrical engineering based on the development of electrical apparatus. I know that if he had survived he would have had a great admiration for the group of productive men that I have mentioned and I hope I would have been included in his listing of such a group.

Calculating Antenna Radiation Patterns

RAYMOND W. CRONSHEY
ENROLLED STUDENT

A graphical method of calculating the horizontal relative field patterns of antennas which will handle any number of antenna elements is described. The complexity of the solution is relatively undisturbed by the number of antennas involved, inasmuch as each element is treated separately, and only the final results from all antennas are added.

CALCULATIONS of the horizontal relative field patterns of antennas are long and laborious and increase in complexity with the number of antenna elements employed. Present calculating machines are useful only for antenna-beam arrays consisting of not over three elements. The system described herein will handle any number of antenna elements and can be used to solve problems in a fraction of the time normally required. Its advantages become more apparent as the number of antenna elements increases. The accuracy of these graphical solutions can be made comparable to slide-rule calculations.

There has always been a need for determining the distribution of relative field strength about transmitting antennas, especially where the design or adjustment of the antenna was concerned. Recently, with the utilization of high- and ultrahigh-frequency radiation, the improvement of performance resulting from the use of antenna "beams" has been used to advantage. In these applications the horizontal field pattern takes on a greater significance, for it is the shape of this pattern that determines the sharpness or directivity of the radiated beam.

There are two types of horizontal field-strength patterns that may be considered. One is the absolute field-strength pattern which indicates how the intensity of the field varies at different distances from the antenna in any one horizontal plane. The field strength at a point in a certain direction away from the antenna will be different from that at another point in the same direction but at a different distance. This type of field pattern is not of too great importance, and its solution will not be considered in this paper.

The second type of horizontal field-strength pattern is the relative field-strength pattern. It indicates the relative field strength in the horizontal plane in one direction as compared to the field strength in any other direction from the antenna. In it linear distances have no function. This is the important field-strength pattern used for determining the directional qualities of an antenna-beam array. In fact, the shape of this pattern usually is considered to be the shape of the beam. Hereafter, therefore, the words "field-strength pattern" are used in this paper to mean relative field-strength patterns, and any references to field strengths are to be interpreted as being relative field strengths.

Figure 1 shows a sample relative field-strength pattern. These patterns are much like the polar diagrams of light distribution that are used in illumination studies. The radial distance of any point on the curve from the center of the graph is an indication of the field strength in that direction as compared to the field strength in any other direction. The longer the radial lines, the greater is the signal strength indicated.

The normal methods of calculation have seemed adequate for most antenna field-form patterns, because most problems heretofore have involved simple antennas of only two or three elements. It is for the calculation of these relatively simple problems that the accepted mathematical solution can be used to advantage. However, the advent of high-frequency antenna-beam transmission has required the solution of problems involving complex antenna arrays which contain many more than three elements.

The usual communications course in electrical engineering for undergraduate students rarely requires the plotting of more than a half-dozen horizontal field forms. The new ultrahigh-frequency courses promise to include much more work in this line. It stands to reason that for a given number of study hours more patterns can be plotted and more knowledge gained if a faster and simpler system for calculating the field patterns is made available. It can be seen that there is a definite need for this new graphical solution in undergraduate work as well as in industry.

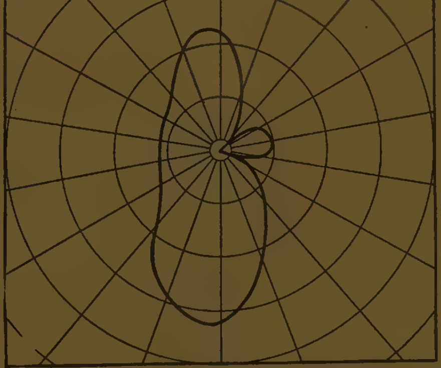


Figure 1. Horizontal field-strength pattern

PRESENT METHODS OF CALCULATION

There are two methods of calculating the field patterns:

1. By mathematical computations.
2. By mechanical means.

The mathematical computations all are based upon the principle given in Figure 2.

Assume two vertical antennas to be located at points A and B. Since the phase of the radiated wave varies (lags) through 360 degrees for every wave length (λ) of linear distance traveled, the phase of the wave from B, relative to A, in the direction of point P would be the initial phase displacement of the currents in the two antennas, θ, plus the phase displacement of the wave as it traveled over distance BY to point Y. In other words,

$$\text{Phase}_p = \theta + (d/\lambda)360^\circ \cos\phi$$

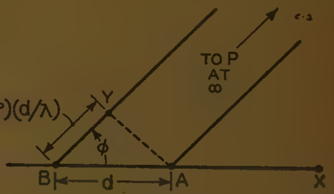


Figure 2. Principle for mathematical computation of field patterns

If some point P in the horizontal plane is chosen, the voltage induced at it will be equal to the vector sum of the two voltages that A and B each would induce in it separately. As point P moves around, describing a circle about the antennas, the variation in amplitude of the induced voltage will indicate definite directional characteristics.

The foregoing equation for phase displacement will hold only when point P

Essential substance of a paper, "A Simple Graphical Method for Calculating Antenna Radiation Patterns," which was awarded the AIEE national prize for Branch paper for the academic year ending June 30, 1943, and the District 5 prize for best Branch paper for 1943. The paper was presented before the AIEE Student Branch at Michigan College of Mining and Technology, Houghton, Mich., January 27, 1943.

Raymond W. Cronshey, a second lieutenant in the United States Army Signal Corps, is currently serving overseas.

is at infinity. However, when point P is far enough distant so that the divergence between the lines $\overline{BP}$ and $\overline{AP}$ is less than four degrees, the lengths of the lines, to all practical purposes, are equal, whether parallel or converging. This condition will be achieved when the distance to point P is over 30 times the spacing between the two antennas. Actually, most receiving antennas are hundreds of times farther away from the transmitters than this, so for all practical purposes the lines to point P may be considered as being parallel. This is a commonly accepted assumption in antenna calculations.

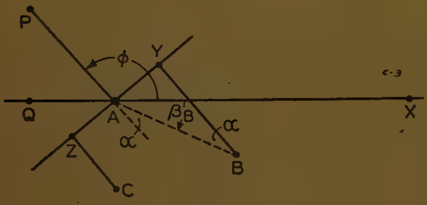


Figure 3

It will be assumed that point P is far enough away from the antennas so that the lines $\overline{PA}$ and $\overline{PB}$ may be considered parallel. Then the wave from B will lag by (d/λ) 360° cos ϕ degrees, because of its longer travel, and by θ_B because of the initial phase displacement of the antenna exciting currents. If E_A is the voltage that A radiation would induce at point P, and E_B is the voltage that B radiation would induce at point P, then

$$E_P = E_A + E_B$$

$$\begin{aligned} E_P = E_A(\cos 0° + j \sin 0°) + {} \\ E_B \cos [(d/\lambda)360° \cos \phi + \theta] + {} \\ E_B J \sin [(d/\lambda)360° \cos \phi + \theta] \end{aligned}$$

In this case E_A is the reference voltage.

If a larger number of antennas is used, the same sort of reasoning can be applied. When more antenna elements are added, a separate set of sine and cosine terms will have to be added for each antenna considered.

In expressing the difference in phase relationship between the reference voltage, E_A, and any other voltage, E_N, the following parameters will have to be given:

1. ϕ, the direction in which the field strength is to be calculated (azimuth from X).
2. d_N, the distance from the reference antenna to antenna N (measured in wave lengths).
3. β_N, the angle that line $\overline{AN}(d_N)$ makes with $\overline{AX}$.
4. $-\theta_N$, the phase angle by which the exciting current in antenna N lags behind that of antenna A.
5. P_N/P_A, the relative amount of power radiated by antenna N as compared to the power radiated by antenna A. (The voltage induced will be directly proportional to the ratio of radiated powers.)

It can be seen that for any problem in which N antennas are used there are $4(N-1)$ variables. For a four-element array the 12 variables become difficult. For eight elements, the 28 variables make a very clumsy equation. A sample four-element equation would appear as follows:

$$E_P = E_A \sqrt{\begin{aligned} &\{P_B/P_A \cos [\theta_B - 360 d_B \times \\ &\cos (\beta_B - \phi)] + P_C/P_A \times \\ &\cos [\theta_C - 360 d_C \cos (\beta_C - \phi)] + \\ &P_D/P_A \cos [\theta_D - 360 d_D \times \\ &\cos (\beta_D - \phi)]\}^2 + \} P_B/P_A \times \\ &\sin [\theta_B - 360 d_B \cos (\beta_B - \phi)] + \\ &P_C/P_A \sin [\theta_C - 360 d_C \cos (\beta_C - \\ &\phi)] + P_D/P_A \sin [\theta_D - 360 d_D \times \\ &\qquad \cos (\beta_D - \phi)]\}^2 \end{aligned}}$$

Once d_N, β_N, θ_N, and P_N/P_A have been determined, they become fixed quantities. Only ϕ is a variable, but it is incorporated in such a form that not much simplification of the equation results. For each point on the field pattern a new value of ϕ must be chosen and the long process of substitution gone through. When enough points have been plotted on polar-graph paper, the field pattern may be drawn through them.

Only two mechanical methods for calculating the field patterns have been described in technical journals[1] at the writing of this paper. These greatly simplify the labor involved, for they draw the completed field pattern. This carries the simplification to the extreme. However, the maximum number of antenna elements which either of the machines will handle is three. Problems dealing with antenna arrays involving a larger number of elements simply cannot be solved by these machines. It is seen, therefore, that some simpler method is required, especially for arrays with a larger number of elements.

BASIC CONCEPT OF THE GRAPHICAL METHOD

A closer inspection of the sample four-element equation indicates that it is the vector sum of $(N-1)$ quantities broken up into their X and Y components. It is of the form:

$$E_0 = \sqrt{\begin{aligned} &(k_1 \cos B + k_2 \cos C + k_3 \cos D)^2 + \\ &(k_1 \sin B + k_2 \sin C + k_3 \sin D)^2 \end{aligned}}$$

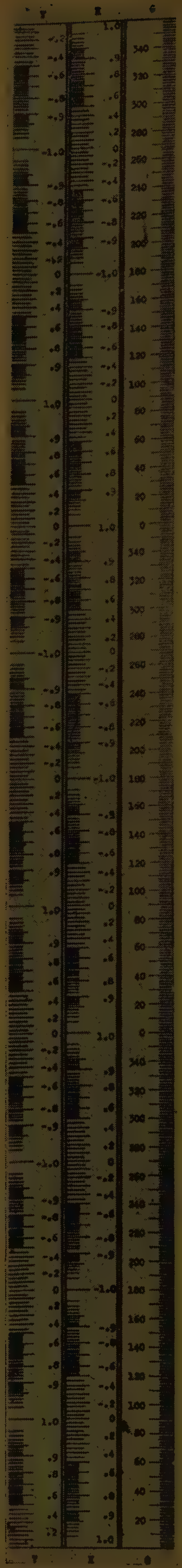
in which the quantities B, C, and D vary with the angle ϕ. The only difficult or laborious part to the solution of such a problem is the determination of the quantities B, C, and D, as the angle ϕ varies, and it is this part of the problem that lends itself admirably to a rapid graphical solution.

Consider the problem in Figure 3 in which three antennas, A, B, and C, are placed as shown. The value of ϕ is such as to place point P in the direction indicated.

The quantity B when broken up into its parts becomes

$$B = \theta_B - 360 d_B \cos (\beta_B - \phi)$$

Figure 4. Linear phasing scale



θ_B is merely a constant from which the rest of the equation will be subtracted. Distance d_B would be a line from A to B. Instead of considering β_B a positive obtuse angle, consider it as a negative acute angle. Then $\cos(\beta_B-\phi)$ becomes $\cos(-\beta_B-\phi)$ or $\cos(\beta_B+\phi)$. Since it is known that $\cos X=-\cos(180°-X)$, then in Figure 3 $\cos(\beta_B+\phi)=-\cos\alpha$.

Thus $360 d_B \cos(\beta_B-\phi)$ becomes $-360 d_B \cos\alpha$. If one looks at Figure 3, it readily can be seen that $d_B \cos\alpha$ is line $\overline{BY}$. The expression for B then becomes

$$B=\theta_B+360\overline{BY}$$

where the line $\overline{BY}$ is measured in wave lengths and $360\overline{BY}$ converts it into degrees. If line $\overline{BY}$ is measured in degrees instead of wave lengths and θ_B is expressed in degrees, then

$$B=\theta_B+\overline{BY}$$

Similarly,

$$C=\theta_C+\overline{CZ}$$

The problem now has resolved itself into one of expressing the length of a line in degrees of phase lag. In Figure 3 assume that the distance AQ is exactly one wave length long. Let a scale be constructed so that a length AQ will comprise 360 evenly divided spaces. Then each space can be used to represent a degree of phase shift. (The phase shift is -360 degrees for each wave length of linear distance traveled.) In this case, the reference line is one through the reference antenna A and normal to the direction $\overline{AP}$. *In the preceding problem, the distance representing the phase lag ($\overline{BY}$ or $\overline{CZ}$) originates at an antenna and is normal to the reference line.*

To find the quantity B or C directly, lay the evenly divided scale along the line $\overline{BY}$ or $\overline{CZ}$ so that the phase angle of exciting current (θ_B or θ_C) is opposite the point representing the antenna (B or C). Then (with the higher-degree end of the scale in the direction toward the reference line) the scale will cross the reference line at the total value of phase displacement $[(\theta_B+\overline{BY})$ or $(\theta_C+\overline{CZ})]$.

This corresponds to the B and C quantities in the equation:

$$E_0=\sqrt{(k_1\cos B+k_2\cos C+k_3\cos D)^2+(k_1\sin B+k_2\sin C+k_3\sin D)^2}$$

It is now necessary to evaluate $\cos B$ and $\sin B$. To dispense with the use of trigonometrical tables in evaluating them, however, a special linear phasing scale has been devised (see Figure 4). It has three fixed scales; θ, X, and Y. The θ scale is a uniformly divided scale with each division representing a degree of phase lag. This is the "evenly divided scale" previously referred to. The X scale is a cosine scale so arranged as to read opposite each degree on the θ scale the value of the cosine of that angle. The Y scale is a sine scale arranged to read opposite each degree on the θ scale the value of the sine of that angle. In using the linear phasing scale it is not necessary to read the value of the phase lag, but merely the values on the sine and cosine scales. These values are read at the point where the scales cross the reference line (line $\overline{ZAY}$ in Figure 3).

The preceding solution of the problem is merely the solution for one point on the field-pattern curve in the ϕ direction. In order to obtain a sufficient number of points to draw a curve, several values of ϕ must be chosen. This merely means that a new reference line must be drawn through A, normal to the new ϕ direction. The linear phasing scale then can be used to measure the distance from B and C to the new reference lines, and thus data for the new points may be obtained.

REFINEMENTS: THE TANGENTIAL POLAR GRAPH

It will be noticed in Figure 3 that the reference line is located between point P and the antennas B and C. When this is the case $\beta_B<\phi$ and $\beta_C<\phi$; thus the quantity $(\beta_B-\phi)$ is placed in the second or third quadrant. The cosines of such angles are negative, making $B=\theta_B+\overline{BY}$. However, when any antenna (for example, B) is located *between* the reference line and point P, the angle $(\beta_B-\phi)$ lies in the first or fourth quadrant thus making $B=\theta_B-\overline{BY}$. This would require that the linear phasing scale be turned end for end in measuring line $\overline{BY}$, thus making an angular subtraction instead of an angular addition.

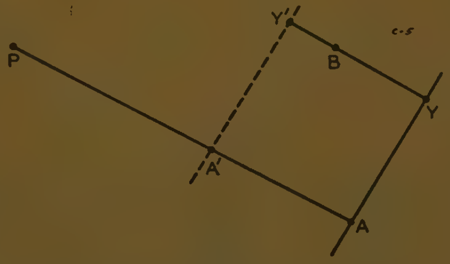


Figure 5. Principle on which tangential polar graph is based

The problem of when to reverse the linear phasing scale and when not to becomes bothersome, and so to eliminate the need for it the tangential polar graph has been devised. Figure 5 illustrates the principle upon which it is based.

Antenna B lies between the reference line and point P. A point A' is chosen such that the distance $\overline{AA'}$ is some integral multiple of a wave length and another reference line $\overline{A'Y'}$ is drawn normal to $\overline{AP}$. Now the new reference line lies between the antenna B and point P, and so the necessity for reversing the linear phasing scale has been eliminated. No inaccuracies will be introduced so long as the distance $\overline{AA'}$ is some integral multiple of a wave length.

It is obvious that, as the direction ϕ varies, the line $\overline{Y'A'}$, of course, will have to move so as always to be normal to $\overline{PA}$. The tangential polar graph takes care of this as shown in Figure 6.

The circle usually can be made one wave length in radius as this will accommodate most problems. At each ten degrees around the circle a tangent has been drawn. These tangents represent the line $\overline{A'Y'}$ in its many positions. Experience has proved that hardly ever is it necessary to plot points closer than ten degrees in order to determine the shape of the field pattern. In fact, only when confronted by sudden changes of shape is it necessary to plot points at intervals any closer than 30 degrees. Consequently the 30-degree tangents are drawn as heavier lines so as to be easily recognized. If it is necessary to resort to ten-degree lines at times, they are included, but only as light lines so as not to add to the confusion. (The crosshatched and the radial lines within the circle are included merely as aids in measuring distances between antennas, and serve no other purpose.)

SAMPLE PROBLEM

Table I lists the conditions of antenna spacing and phase excitation to be used in a sample problem.

With the assistance of the guide lines, four dots can be placed upon the tangential polar graph with a pencil, each dot representing one of the four antennas. This is shown in Figure 7. The information in column 2 can be transferred to the graph by measuring the distances from point A (always at the center of the circle) with the degree scale of the linear phasing scale (one-quarter wave length=90 degrees, one-half wave length=180 degrees, and so forth). Assume that one desires to determine E_P in the direction $\phi=30$ degrees (from line AB). The 30-degree tangent bar then will be used (analogous to line $Y'A'$ in Figure 4).

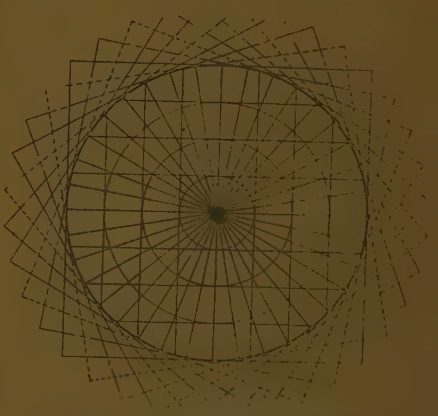


Figure 6. Tangential polar graph

Table I. Conditions of Antenna Spacing and Phase Excitation for Sample Problem

1 Antenna	2 Distance in Wave Lengths	3 Phase Angle of Exciting Current	4 P_N/P_A	5 Displacement (Vertex at A)
A	0	0	1	
B	1/4	56	1	
C	1/2	−20	1	80° from *B*
D	1/2	0	1/2	280° from *B*

Table II

Direction ϕ = *30°*

Antenna	Sin	P_N/P_A Sin	Cos	P_N/P_A Cos
A	0	0	1.0	1.0
B	−0.91	−0.91	−0.43	−0.43
C	−0.99	−0.99	−0.12	−0.12
D	0.88	0.44	0.48	0.24
Total *Y* co-ordinate		−1.46	Total *X* co-ordinate	0.69

Starting with antenna *B* (and remembering that the degrees on the linear phasing scale are angles of *lag*) set the 324-degree mark of the linear phasing scale over point *B* and rotate the scale about point *B* until it (the scale) is normal to the 30-degree tangent. (In all cases the scale should have its high-degree end pointing toward the tangent.) The scale will cross the 30-degree tangent line at cosine = −0.43, and sine = −0.91. Thus the vector voltage that antenna *B* would contribute at point *P* has been broken up conveniently into its *X* and *Y* co-ordinates without any calculations whatsoever. For antenna *C* the scale is set with the 20-degree mark over point *C* and the scale adjusted so as to be normal to the 30-degree tangent. Antenna *C*'s contribution is read as cosine = −0.12, and sine = −0.99. For antenna *D* the scale is set with zero degrees over point *D*, and *D*'s contributing voltage read as cosine = 0.48, and sine = 0.88.

These values are conveniently classified in Table II.

Relative value of induced voltage at point $P = E_P/E_A$

$$E_P/E_A = \sqrt{(0.69)^2+(1.46)^2}$$
$$= 1.60$$

This value, of course, is the voltage with reference to the voltage of a single antenna element (*A*) which is just what is required in plotting field-form patterns. The field pattern for the preceding array is shown in Figure 1.

COMPARISON WITH PRESENT METHODS

It is quite evident that this is much easier than substituting 12 variables ($4(N-1)=12$) into the usual equation and then painstakingly computing the answer. The initial step of placing the dots upon the polar tangential graph should not require over a minute. This is comparable to substituting in the 12 variables (all but ϕ). The second step is the evaluation of the sine and cosine terms and the extraction of their square root. This is comparable to substituting the value of $\phi(30°)2(N-1)$ times into the clumsy equation and then calculating the results.

When it is realized that the foregoing operation must be carried out for every point which is plotted on the field-form pattern, it is quite evident that:

A. The graphical solution has a distinct advantage in that it requires less time.

B. The advantage becomes more and more pronounced as the number of antenna elements increases.

In addition, it might be said that the only calculation required with the graphical method is the computation of the hypotenuse of a right triangle; thus the handling of mathematics and the resulting chances of error are reduced to a minimum.

ACCURACY

It has been found possible, using the actual linear phasing scale and tangential polar graph, to solve problems with sufficient accuracy that the value of the sine and cosine terms could be read to two and many times (at one end of the scale) to three significant figures. It seems entirely possible that, by increasing the size of the graph and the scale, the accuracy can be made even greater. One last advantage that may not have seemed too apparent at first is the fact that both the graph and the scale may be used over and over again. If the points representing antennas are made in pencil, they may be easily erased, leaving the tangential polar graph ready to be used again.

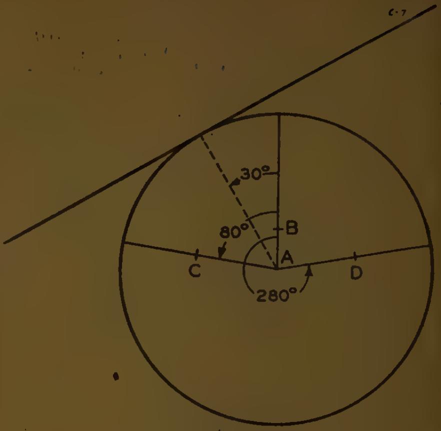


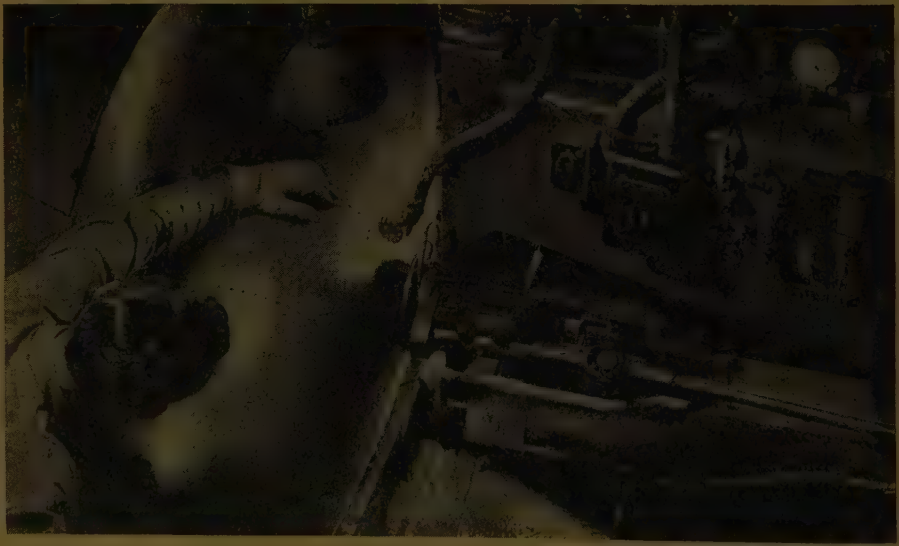
Figure 7

In conclusion, it might be said that with the two simple tools described in this paper, the student and the engineer will be capable of solving the most intricate field-form problems, involving up to an almost infinite number of antenna elements, in a minimum of time and with a minimum amount of effort.

REFERENCE

1. *Proceedings* Institute of Radio Engineers, May 1942.

Gasoline Tanks Electrically Welded



General Electric photo

Electronically controlled resistance welders now seam-weld these detachable gasoline tanks for the Lightning *P*-38 fighters in four minutes at the rate of 60 inches per minute. Since no additional metal is deposited in this process, welding rod ordinarily consumed in rod welding is saved. The process also permits the substitution of steel for the aluminum formerly used. Two of the streamlined tanks are attached like pontoons to the airplanes and, when empty, may be dropped off if the fighter needs to gain speed.

Temperatures Produced by Overloading Oil-Immersed Transformers

E. W. TIPTON
MEMBER AIEE

Power transformers have characteristics that permit the carrying of overloads for short periods of time, provided temperature limitations are not exceeded. The determination of permissible loading is reviewed in this article for the guidance of transformer operators.

TRANSFORMERS have thermal capacity; furthermore, they frequently show lower temperature rises during test than the guaranteed rise. Load factors are usually under 100 per cent and rarely are ambient temperatures continuously 40 degrees centigrade. For these reasons it usually is possible to get out of them more than is indicated by their nameplate ratings.

To illustrate the effect of thermal capacity, consider an ordinary spiral-wound coil made of paper-insulated copper, such as is used in power transformers. In air, it must carry 700 per cent of normal current for five minutes before the paper coating can be charred, but to do the same thing in oil, a much larger current is required. This property makes it possible for transformers to handle extra loads which today are vital to war production.

The load which a transformer can carry is limited by the ability of its insulation to withstand high temperatures. In most cases this insulation consists of cotton, linen, paper, pressboard, varnish, and oil. Many years ago a value of 105 degrees centigrade was established as the upper temperature limit for such materials. This limit still exists in AIEE Standard 1. From this value came the well-known 55-degree-centigrade rise standard for transformers. It was based on the assumption that the hottest spot in the transformer (which cannot be measured conveniently) might be 10 degrees centigrade hotter than the average temperature rise as determined by resistance. The latter quantity is easily measured. Subtraction of this 10-degree-centigrade allowance from the 105-degree-centigrade limiting temperature, with the assumption of a maximum ambient temperature of 40 degrees centigrade (104 degrees Fahrenheit), leaves a permissible temperature rise of 55 degrees centigrade.

The standard method of rating has worked out very well, in general, and transformers so rated have had a satisfactory life. One reason that it has worked so well is that apparently there have been few instances where a free-breathing transformer (which tested right up to the permissible 55-degree-centigrade rise by resistance) has been operated continuously at full rated load with a unity power factor in a steady 40-degree-centigrade ambient temperature. Under such conditions oil would deteriorate quite rapidly. Because of this fact, modern transformers have some means for protecting the oil from oxygen by maintaining an inert atmosphere of nitrogen in contact with the hot oil. Then too, present American Standards specify that average ambient temperature over a 24-hour period should not exceed 30 degrees centigrade, with a maximum at any time of 40 degrees centigrade.

Various standardizing agencies have published a number of guides which tabulate maximum allowable hot-spot temperatures permitted for given periods of time. American Standard C57 permits a continuous hot-spot temperature of 95 degrees centigrade, which experience indicates will give satisfactory life. Also, without appreciable loss of life, recurrent short-time overloads (not oftener than once in 24 hours) and emergency overloads (unexpected overloads of infrequent occurrence) are permitted with temperatures as shown in Table I.

In addition to these limits, certain maximum temperature limits were established in 1942 for emergency overloads that may result in moderate loss of life not to exceed one per cent for each application.[1] These values apply only to modern transformers having adequate means for protecting the oil from oxygen.

Transformer operators may follow the data in Tables I and II or establish other limits which, based on experience, will result in satisfactory operation.

When a method for determining maximum permissible temperature is established, it is necessary, if such information is to be of any value, to be able to calculate what the hot-spot temperature will be after carrying a particular load for a given length of time. Fortunately, formulas for calculating hot-spot temperatures of an oil-insulated transformer are not difficult to use. The temperature of the hottest spot in the winding is made up of three parts: the ambient temperature, the oil temperature rise, and the difference between hot oil and hot copper temperatures (usually called the gradient). This may be written:

$$T_{HS}=T_A+T_O+T_G$$

Overload calculations are based on test results at full rated load and it is assumed that the oil rise varies as the 0.8 power of the total losses, and that the gradient varies as the 0.8 power of the copper loss. These assumptions are not exactly true but they check experimental results very closely. In the form of an equation, this may be written:

$$\begin{aligned} T_{HS}&=T_A+\left[\frac{1+RL^2}{1+R}\right]^{0.8}T_O+T_GL^{1.6}\\ &=T_A+MT_O+T_GL^{1.6} \end{aligned}$$

T_{HS} = hot spot copper temperature, degrees centigrade
T_A = ambient temperature, degrees centigrade
T_O = oil rise at full load, degrees centigrade
T_G = gradient at full load, degrees centigrade
L = per unit load
R = ratio of copper loss to iron loss at full load

This formula will give the final temperature of the hottest copper for any load which continues until a temperature balance is reached.

To find temperature at the end of any time t, it is assumed that the temperature of the oil changes (from its value when the

Table I. Temperature Limits for Hottest Spot in Transformer Windings

American Standard C57

Duration, Hours	Degrees Centigrade Recurrent Overloads	Degrees Centigrade Emergency Overloads
2	110	115
8	105	110
24	95	105

Table II. Temperature Limits for Hottest Spot in Transformer Windings

AIEE Interim Report on Overloading Transformers

Duration, Hours	Temperature Limit, Deg C
1	137
2	130
4	125
8	120
24	110

E. W. Tipton is transformer engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa.

load is applied to its final value) according to an exponential law. Also, since the thermal capacity of the copper is relatively small, it is assumed that the gradient reaches its final value at once. This results in only a small error for intervals greater than one-half hour. Ordinarily, in calculations of short-time overloads it is assumed that the transformer has been fully excited but has been carrying no load, or that it has been fully loaded just before the overload is applied.

The general formula for temperature at any time is:

$$T_{HS}=T_A+T_i+(MT_O-T_i)\ (1-\epsilon^{-t/b})+T_GL^{1.6}$$

For overloads following no load, this becomes:

$$T_{HS}=T_A+T_O[M+(N-M)\epsilon^{-t/b}]+T_GL^{1.6}$$

And for overloads following full load:

$$T_{HS}=T_A+T_O[M+(1-M)\epsilon^{-t/b}]+T_GL^{1.6}$$

T_i = oil temperature at start of overload, degrees centigrade
t = time in hours
b = thermal time constant of oil temperature rise

$$N=\left[\frac{1}{1+R}\right]^{0.8}$$

$$M=\left[\frac{1+RL^2}{1+R}\right]^{0.8}$$

These formulas look rather complicated and they do involve fractional powers and exponentials. However, they are reduced to simple multiplication and addition by means of the curves in Figures 1 and 2. In Figure 1, the value of N is plotted as a function of the ratio of copper to iron loss at full load. The value of this ratio is available from the transformer test sheet. Also, on this figure it is possible to read the values of the exponential for any value of t/b, and the value of $L^{1.6}$ for any value of L. Figure 2 gives the value of M for any ratio of losses at various overloads. If it is desired to avoid interpolation, the fraction $\frac{1+RL^2}{1+R}$ can be calculated and raised to the 0.8 power by means of the curve on Figure 1.

All data necessary for using this method of calculation are available to the transformer operator. Ambient temperature may be taken from his own records. The ratio of copper to iron loss at full load, the transformer-oil temperature rise at full load, and the gradient at full load can be obtained from the transformer test sheet furnished by the manufacturer. The gradient on the test sheet is the difference between the hot oil and average copper temperatures. To this value must be added a hot-spot allowance which is customarily taken as 10 degrees centigrade although it may frequently be less.

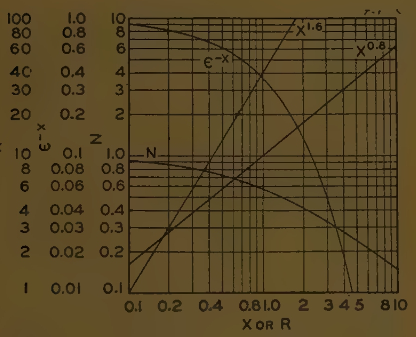


Figure 1. Working curves for calculating overload temperatures

$$N=\left(\frac{1}{1+R}\right)^{0.8}$$

R = ratio copper loss to iron loss at full load

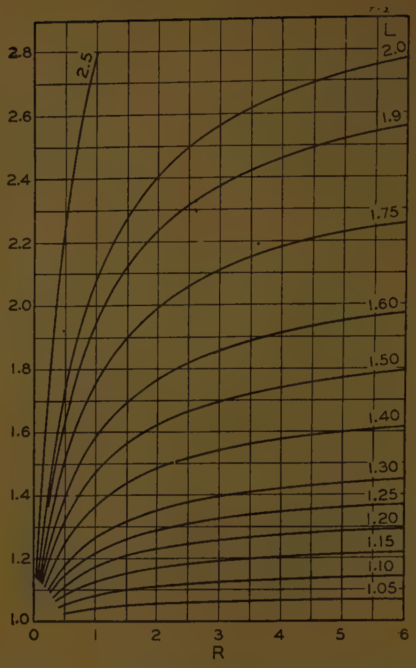


Figure 2. Auxiliary curves for overload temperature calculations

$$M=\left(\frac{1+RL^2}{1+R}\right)^{0.8}$$

R = ratio copper loss to iron loss at full load
L = per unit load

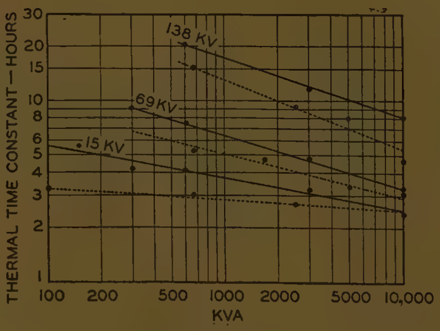


Figure 3. Typical thermal time constants for transformers

Solid lines three phase, dotted lines single phase

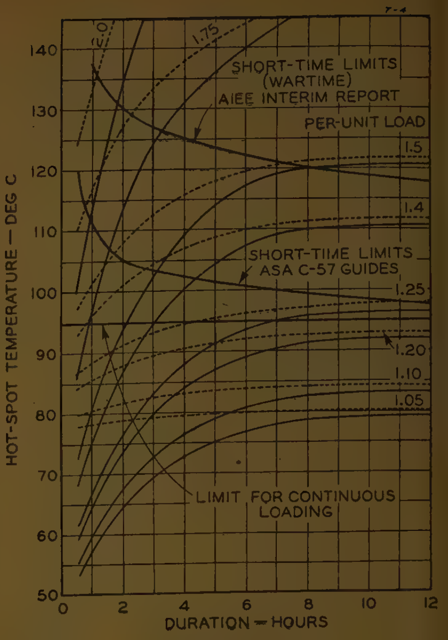


Figure 4. Transformer overload temperature curves for a typical single-phase unit

2,500 kva, 15 kv, time constant 2.66, ambient temperature 15 degrees centigrade, ratio of losses 3.17, gradient 18 degrees centigrade, self-cooled, oil-immersed

Solid lines following no load, dotted lines following full load

Transformer time constant is given by the formula:

$$B=\frac{CT_O}{W}$$

B = thermal time constant
W = total watts loss at full load
T_O = oil rise at full load

$$C=\frac{3.5\ (\text{pounds of core and coils}+{}^2/_3\ \text{pounds of tank})+12\ (\text{pounds oil})}{60}$$

Of the factors required, watts loss and oil temperature rise can be obtained from the transformer test sheet and weights are engraved on the transformer instruction plate. The thermal time constant is a measure of the time required to heat the materials of which the transformer is built. Figure 3 gives typical values for standard self-cooled oil-immersed transformers. It will be observed that the time constant increases with the voltage class. Operation at higher voltage requires greater insulation clearance and therefore more iron, copper, and oil are required for a given kilovolt-ampere rating. Also, time constant decreases as kilovolt-ampere increases because insulation clearances (which are constant) have less effect on materials required as capacity increases.

Use of calculations (as reviewed before) for determining transformer loading has the advantage that it may be applied to a particular transformer. It permits taking maximum advantage of each favorable factor. Thus, loads are not limited

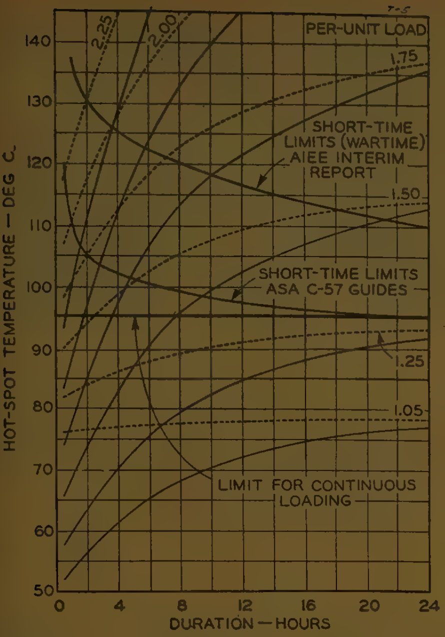


Figure 5. Transformer overload temperature curves for a typical three-phase unit

10,000 kva, 138 kv, time constant 8.1, ambient temperature 15 degrees centigrade, ratio of losses 1.78, gradient 14 degrees centigrade, self-cooled, oil immersed

Solid lines following no load, dotted lines following full load

by considerations that must be applied so as to be safe for the worst possible case in a whole class of designs. One way to utilize the formulas involves plotting a set of overload curves for a particular transformer and superimposing (on this curve) the allowable temperature limits.

Figures 4 and 5 are overload curves for two typical self-cooled transformers. As may be noted, there are two curves each for a number of different overloads—one following no load, the other following full load. Over these curves are plotted a second set of curves showing the temperature limits of the AIEE interim report, the American Standard C-57 limits for emergency and recurrent overloads, and also the American Standard C-57 limit of 95 degrees centigrade for continuous loads. The temperature limitations are independent of the ambient temperature. The load-temperature curves, however, are dependent directly on the ambient temperature. They are drawn on Figures 4 and 5 for a 15-degree-centigrade ambient temperature. The value of temperature read from these curves must be increased 10 degrees centigrade when the ambient temperature is 25 degrees centigrade or decreased 10 degrees centigrade when the ambient temperature is 5 degrees centigrade. When operating with a 15-degree-centigrade ambient temperature the intersections of the transformer overload curves with the American Standards Association and AIEE temperature-limit curves determine the length of time for which various overloads may be carried without exceeding the standard limiting temperatures.

If the ambient temperature differs from 15 degrees centigrade, then the winding-temperature curves must be replotted if it is desired to read correct values of both winding temperature and safe temperature limits. If, however, it is desired only to find how long a load can be carried without exceeding any given temperature limit a simpler method may be used. Transformer overload curves are plotted for the most convenient ambient temperature, and the standard-temperature-limit curves are plotted on the same sheet. Then, on a transparent curve sheet using the same scales, the AIEE and ASA safe temperature limits are plotted. By placing this second sheet over the first so that the scales coincide, safe values for the ambient temperature selected may be read. For higher ambient temperatures the transparent curve sheet is shifted down an amount equal to the difference between the desired ambient temperature and that for which the overload curves are plotted, and for lower ambient temperatures it is shifted upward.

Curves of Figure 4 are drawn for a single-phase low-voltage transformer which has a time constant of 2.66. It may be noted that the winding temperature approaches its final value at the end of eight hours. Figure 5 is plotted for a three-phase high-voltage transformer which has a time constant of 8.1, nearly three times as great. In this case, it is only after 24 hours that the temperature curves begin to flatten out. Following no load, the single-phase transformer will carry a load of 150 per cent for two hours before reaching a winding temperature of 95 degrees centigrade. The three-phase transformer will carry 150 per cent load for 7.8 hours before reaching the same temperature.

Curves of the type shown in Figures 4 or 5 can be drawn for any transformer and can be used to determine safe loading cycles. In determining safe temperature limits, care must be taken to consider limitations mentioned in the ASA guides for operation and in the AIEE interim report. The values in the interim report apply only to modern transformers having means for protecting the oil—lower limits must be used for older transformers. Capacity of auxiliary apparatus such as tap changers, bushings, reactors, also must be considered. If calculations are carefully made, a large amount of transformer capacity (over and above that shown on transformer rating plates) can be made available.

REFERENCE

1. Interim Report on Guides for Overloading Transformers and Voltage Regulators, AIEE transformer subcommittee. AIEE *Transactions*, volume 61, 1942, September section, pages 692–4.

Calculator Widens Scope of Practical Mathematics

This versatile calculating machine recently was presented by International Business Machines Corporation to Harvard University to be used by the United States Navy for the duration. Employing a unique automatic sequence control which receives problems on a coded tape, the machine will solve practically any known problem to 23 significant figures, including problems involving computation and tabulation of functions, evaluation of integrals, solution of simultaneous linear algebraic equations, and harmonic and statistical analysis. Its basic performance comprises addition, subtraction, use of parentheses and brackets, multiplication, division, interpolation or the location of values of functions in mechanical tables of mathematical functions, card punching of computations, card feeding, and storage of numerical data. Particularly benefited by such calculations are the fields of atomic physics, electronics, actuarial work, optics, and astronomy. The operator of the machine need not be a trained mathematician, but the problem must be coded by one.

This 51-foot calculator contains 500 miles of wire

Electrical Engineering in the Postwar World

V. The Electric-Power Industry After the War

T. G. LeCLAIR
FELLOW AIEE

The improved electric service in the home, the farm, in commerce, and in industry which will result after the war as an outcome of new developments is discussed in detail. Improved power applications will increase production and decrease labor, predicts this power-company engineer. The conversion problem from wartime to peacetime industry will be much greater than that of the last war, especially for the utilities.

THE plans of the electrical industry, and of the utility industry in particular, for the postwar period are not a new subject. In the utility business where it takes nearly three years to build a new power plant, planning for the future is a routine part of the job. Postwar planning is the same job except that some of the plans must have an *X* date instead of a definite date for beginning construction.

To see what the future holds for us as electrical engineers, we must look at the uses to be made of electricity. This industry includes the manufacturers of equipment as well as the utilities which sell the energy to operate this equipment. At the beginning of the war a number of new developments were about to be put on the market of considerable importance to this industry. Others have been developed during the war period. They cover the entire field including the home, farm, commercial applications, and, last but not least industrial production of both war and peace goods.

ELECTRICITY IN THE HOME

Let us look first at the possibilities for the electric service in the home. Perhaps one of the most important improvements which can be expected to find a ready acceptance is the home freezer. The quality of frozen food has been improved steadily, and the wartime lessons in the preparation of frozen food will make this much more acceptable. I believe that freezers to keep food in a solid state until needed will become even more popular than the ordinary refrigerator did in the late '20's.

One type of frozen food storage is the basement unit in which fresh foods can be frozen at home. Many of these units are in use in which practically a whole winter's supply of vegetables and meat may be stored. This type of freezing unit is expected to be available both in the form of units for the individual home and multiple units to be placed in the basement storeroom of an apartment building with a locker for each apartment.

Figure 1 illustrates the home freezer combined with the ordinary refrigerator. Some manufacturers have this device now ready to market and consider that it will be more popular than the basement-type freezer. It will be very satisfactory in built-up areas as soon as delivery service is available for frozen foods. The freezing locker in this unit is a relatively smaller compartment underneath the regular food compartment. It will have space for only a few days' supply on the assumption that the food is prepared and delivered in frozen form.

Television is another new development for which there is a popular demand. Just prior to the war a few vision stations had been started, and a number of home television receivers are now in use. Several manufacturers have stated that they can market the home receiver at a reasonable price. Thomas F. Joyce of the Radio Corporation of America recently announced publicly that he believes that television will become a billion-dollar industry shortly after the end of the war. Figure 2 illustrates a postwar design of home television receiver which can be combined with radio to provide an opportunity both to see and to hear a program simultaneously.

The trend toward the completely electrified kitchen was just getting its stride at the beginning of the war and will certainly continue. The modern electric range with its cleanliness, convenience, and safety will be coupled with the new complete refrigerator and the dishwasher.

At the same time home laundry equipment is improving in quality, and the automatic washer is taking more of the drudgery out of doing washing at home. Figure 3 illustrates a laundry combination including a washing machine on the right; a tumbler drier, shown in the center, which dries the clothes with hot air and fluffs them nicely; and a modern pressing machine. This particular washer is not automatic, but automatic washers are now ready to market. Other devices which will make home a more comfortable place in which to live include the modern completely automatic electric range, the electric water heater, the home-cooling unit, and the electronic air cleaner.

These expanded uses of electric service cannot be obtained without solving some problems which engineers will understand. To sell twice as many kilowatt-hours in a home means the use of larger wire and more electric circuits to insure that these appliances will perform in a way that they are intended. As engineers, we must see that all new homes and remodeled homes are provided with adequate wiring, so that new appliances can be installed at a reasonable cost whenever they are purchased.

ELECTRICITY ON THE FARM

In 1943, 40 per cent of the farms in the United States were electrified, and 82 per cent of the farms in Northern Illinois were receiving electric service. The farmer's wife is entitled to the same benefits of electricity for home comforts as the home owner who lives in the city. At the same

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Essential substance of an address presented before the Illinois Valley Subsection of the AIEE Urbana Section, in Peoria, Ill., May 18, 1944.

T. G. LeClair is staff engineer with Commonwealth Edison Company, Chicago, Ill.

time electricity has a multitude of other uses on the farm. Figure 4 illustrates one of the many ways in which electricity can save labor by hoisting the hay into the barn. Similar motors can perform a hundred and one other tasks including grinding feed, pumping water, or stirring milk. The shortage of farm labor during the war has taught the farmer much about the dependability of electric service and the savings which it can make in the expense of farm operation.

ELECTRICITY IN THE COMMERCIAL FIELD

In the commercial field fluorescent lighting was just getting its start at the beginning of the war. During the war almost all fluorescent lighting was confined to war plants, because such lighting equipment was on a priority basis. More attractive fixtures and built-in equipment will be the regular practice in the store of the future. Many shops have been closed because of lack of man power and lack of merchandise. When they reopen, each owner will take pride in a modern lighting installation to attract his customers.

Restaurants probably will adopt more electric cooking. This equipment has much to offer in the way of cleanliness and convenience. There are many other applications including the sterilamp to preserve food and the electric precipitator which will take the smallest particle of dirt out of the air that engineers will develop in the next few years.

ELECTRIC POWER IN INDUSTRY

Our biggest wartime lessons in the use of electric power have been learned in the industrial field. War plants have been compelled to use power for production to the maximum extent to replace hand labor with the steadily increasing labor shortage in all industrial areas. It is ridiculous to imagine that these lessons will be forgotten in the period of future civilian production.

In the 20 years from 1919 to 1939 the horsepower per worker in factories nearly doubled. We have no recent statistics, but there is no question that this figure has increased much further. If we are to maintain or raise the American standard of living after the war, we must increase the output per worker of the goods and services which we desire to use. The use of power for more production has given America leisure time for education and pleasure. The use of more power to replace hand labor is the open road toward a still higher standard of living.

One of the best aids to increased production in industry is better lighting. Fluorescent lighting and other forms of gaseous-tube sources have taken a new spurt in the war period. Many civilian factories will certainly be modernized with this form of lighting after the war.

The newest industrial use of electricity with a wide field is the use of high frequency for heating. This high-frequency heating is divided roughly into two classes. One class is used for heating materials which are nonconductors of heat and electricity and is called electrostatic heating. The other class of high-frequency heating is called the induction type where the material is heated by electric current induced in the metal by magnetic field.

Figure 5 illustrates the electrostatic form of heating suitable for rubber, ceramics, plastics, wood, and the like. The high frequency is used to bond sheets of wood together with a plastic material. The

Figure 3 (top). Laundry combination including (left to right) modern pressing machine, tumbler drier, and washing machine

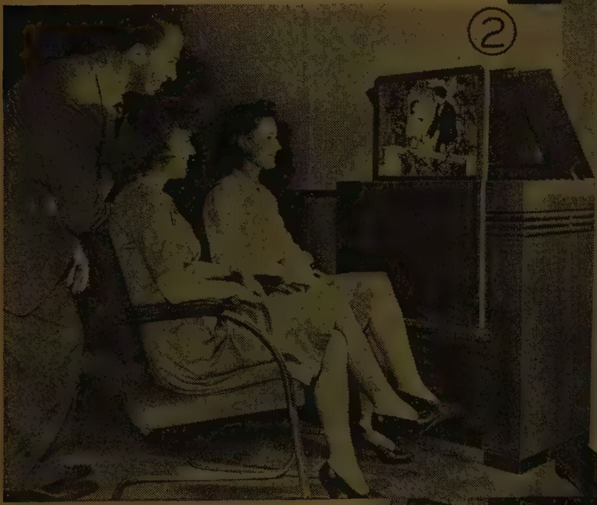

Figure 2 (above). Postwar design of home television receiver which can be combined with radio to provide an opportunity to see and hear a program simultaneously

Figure 1 (center). Home freezer combined with ordinary refrigerator

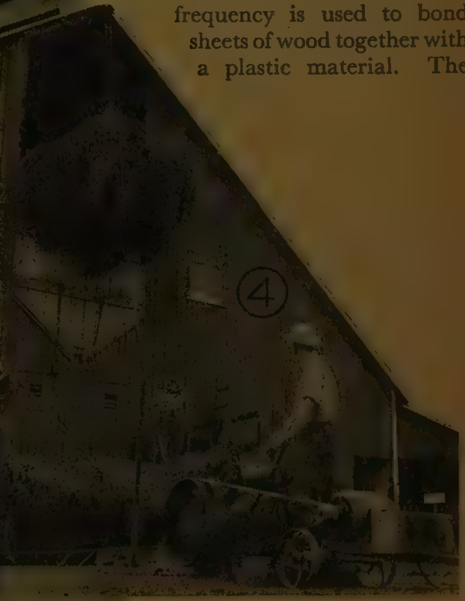

Figure 4 (above). Electric motor hoisting hay into barn

Figure 5. Electrostatic form of heating suitable for rubber, ceramics, plastics, and wood

alternate sheets of wood and plastic are placed between two electrodes under a mechanical pressure. The application of high frequency to these electrodes generates a uniform heat throughout the wood and plastic, so that the bond can be formed in 12 minutes. With steam heating it took two hours for the heat to penetrate, and the outer layers were overheated before the center was well bonded.

Induction heating is beginning to find a wide variety of uses. Frequencies from 3,000 to 2,000,000 cycles per second have been used for quick brazing and soldering of metals. Equipment to heat heavy shell cases for forging uses still lower frequencies from 60 to 3,000 cycles, depending on the thickness of the structure to be forged. The fact that heat can be concentrated on the part of the structure requiring it makes this method of heating far more economical than any other available form.

The greatest single use of induction heating at the moment is for hardening the surface of steel. By this means heat is concentrated on the surface without warping the structure. The depth of the hardness for a particular application is inversely proportional to the frequency of the induced current.

Welding is another development which has come forward at a very rapid rate during the war period. Welding units use automatic machines to control the speed of welding and the amount of metal deposited during the welding process. Such automatic welding produces a uniform product without blowholes and with a very substantial saving in time. Electric welding undoubtedly will take the place of many other methods for the fabrication of metal products after the war. With the development of the newer alloys, electric welding and brazing are the only practical means by which these new materials can be joined.

CONVERSION FROM WAR TO PEACE

The important problem for postwar planning in the electrical industry is to translate the hundreds of new developments into terms of what we will have to do. The problems of converting this industry or any industry to peacetime conditions require a study of past conditions before we predict what we can expect in the future.

The conversion problem for the whole country is a bigger one than faced us at the end of the last war. The present war already has lasted longer than the World War I, and the United States has been in the war more than a year longer than the total time in the last conflict. This has necessitated a more complete conversion to a wartime economy and will entail a longer road back to civilian life.

Figure 6 illustrates the much greater extent to which we have been on a war basis. In 1918 the war expenditures rose to a maximum of $18,400,000,000 while the national income was $57,000,000,000. In 1943 the war expenditures were $85,000,000,000 and the national income $148,000,000,000. Therefore, the war expenditures instead of being one-third of the national income as in 1918 are now approaching 60 per cent.

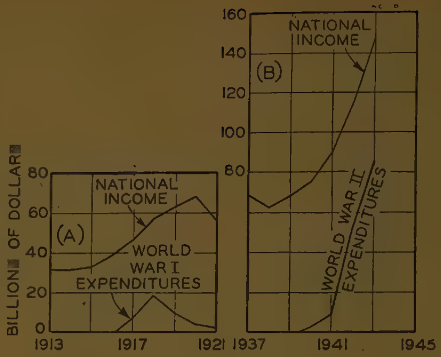

Figure 6. National income and war expenditures

A. Source: E. L. Bogart and National Industrial Conference Board

B. Source: National Industrial Conference Board

The national income in 1943 rose to this high level because of the necessity of war production. Much of this high level has resulted from the temporary employment of homemakers and other marginal workers in industry, as well as from longer working hours. For the postwar period with the reduction in the work week to 40 hours and the return of soldiers, *Fortune* magazine has estimated that the national income should be approximately $138,000,000,000 to maintain prosperity and full employment. The Department of Commerce and other sources have estimated approximately the same figures. Most of this national income will be from civilian pursuits, even though we maintain a larger armed force than in prewar years.

For the utilities the contrast between wars in the conversion problem is even greater, as the amount of power used in industry is coming more and more from utility companies, public and private. Figure 7 illustrates this point by showing the steady increase in the proportion of industrial power which is produced by outside utilities. The lower right-hand chart shows that practically all the increase in the power used in factories since the last war has taken the form of electric motors operating on purchased power. The percentage of power in factories purchased increased from 30 per cent in World War I to 60 per cent in 1940. The upper left-hand chart shows that since 1940, with the sharp increase in war production, the percentage has risen to 70 in 1943.

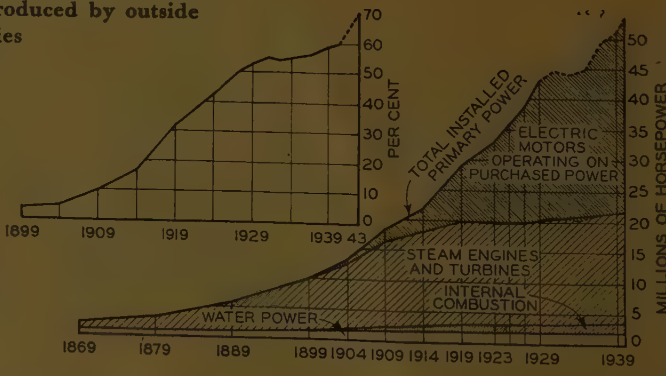

Figure 7. Steady increase in proportion of industrial power produced by outside utilities

A (upper). Percentage of electric motors operating on purchased power

B (lower). Growth in use of factory machinery in the United States

United States Census of manufactures (years between 1929 and 1939 estimated by the Edison Electric Institute)

LOAD ESTIMATES FOR FUTURE TRENDS

In the systems served by the Commonwealth Edison group of companies, the customers are divided into five classes: rural, residential, commercial, industrial, and electric railroads. The kilowatt-hour sales by years to each of these classes are shown in Figure 8. In the ten years from 1933 to 1943, the industrial sales have more than tripled, a large part of this increase being due to the war effort. Rural sales have increased at a tremendous rate, but they do not represent a large proportion of the total. Commercial sales have grown more slowly and have even fallen off in the last two years, because of the inability of small stores and small industries to get materials. The residential load growth has been steady through good times and bad. The supply to electric railroads is neither increasing nor decreasing with the exception of the last two years when there has been some increase because of shortage of gasoline and tires.

It is interesting to speculate what will happen to these various types of load after the war. Those responsible for estimating load trends in Northern Illinois are continually at work sounding out customers as to their plans, and checking and rechecking all conditions which might influence the load in any given classification. The estimated future trends are shown on the right side of Figure 8. It is estimated that with proper sales campaigns, because of the new appliances and devices which will be brought on the market, and for other reasons previously mentioned, the residential load growth is pointed toward a goal of double the 1942 levels at the end of the first five postwar years. In the rural area where about 82 per cent of possible rural customers are now being served, it is expected that the load and the output will more than double. The commercial load is expected to recover promptly to levels higher than at any time in the past as a result of the improvement of business conditions generally, and the fact that money will be available for the purchase of all kinds of material and conveniences which have been unobtainable during the war. The railroad load which has increased slightly during the war probably will taper off gradually as gasoline and tires for automobiles become available for transportation to and from work. The industrial load probably will drop back nearly to the 1940 level and from there on again will begin to rise. Just how fast these loads will change after the war will depend, of course, on the manner in which the war ends. Consequently, in all these charts a space has been left after 1943 which should indicate first, that we do not know when the war will end and, second, that we do not know how it will end; consequently, we cannot predict the shape of the curve in this uncertain period.

Many estimates have been made by representatives of utilities in various parts of the country. These estimates differ because estimators differ on future general business conditions, and, to a much greater degree, because of the local conditions in the area served. Those areas with strictly war plants, such as shipbuilding and airplane manufacture, undoubtedly have the greatest future problem. Nonindustrial areas probably will have less of a conversion problem for the utility. You may be interested in a few of the preliminary estimates made by representative utilities as to what their maximum demand will be after the war. In Figure 9 the peak load for 1943–44 is used as 100 per cent, and the estimated demand at the end of the first full calendar year after the close of the war is the first point of the prediction. The most optimistic estimate shows a load in the first postwar year 13.5 per cent higher than the 1943 peak. The most pessimistic expects that at the end of the third year after the war the recovery will have reached only 94 per cent. These maximum-demand estimates all are greater than the predicted increase in kilowatt-hours, because the change from war time to standard time has been estimated to increase the national demand as much as 1,500,000 kilowatts, and may increase the demand in the Chicago area by 70,000 to 100,000 kilowatts.

The picture for the Commonwealth Edison group of companies might be considered representative of many other areas, because this territory includes everything from the densely populated city of Chicago to a large rural area. The predicted rates of load growth by classes have been translated to an estimated rate of load growth for the total system as shown in Figure 10. It will be noted that this prediction shows the total system load coming back to the present levels in about the third year after the end of the war. Some utility operators who have seen this estimate consider it optimistic, but we believe it is based on the study of conditions such that it is perfectly attainable. With anything like good business conditions there is no reason why this goal cannot be attained.

The electric-power industry has a special opportunity to help provide continued prosperity and improved living in the future in the United States. In so doing, that industry will offer a multitude of opportunities for engineering work in many new and interesting fields as well as in present fields. The term "electric-power industry" is used in its broader meaning to include the manufacturer of electric equipment; the utility which supplies the power to the users; and the utilization of electric power for an increasing number of services in industries, farms, homes, and elsewhere. The entire power industry is only scratching the surface of the problems which require engineering talent.

EFFECT OF NEW DEVELOPMENTS

In the electric utilities field there are many new developments which will affect our engineering in the postwar period. For example, we must study the developments on insulations that withstand extra high temperatures to see what savings in materials can be made by their application. Noninflammable transformers and air circuit breakers are available, but full use of these new developments has not yet been made in saving the cost of protective enclosures. The reliability of modern equipment and installations is such that we should make every effort to simplify designs all the way from the generating station through the system to the customers' meters. By these improvements in plans we can give equal service with decreased cost and can have a system which is more flexible to provide for unexpected load growth.

There is some possibility that efficient and relatively inexpensive sources of power may be available in small units. We must be alert to use these small power sources for special power plants or for application at remote parts of the distribution system to insure that the industry continues to supply the most efficient brand of service from whatever source feasible.

In industry we must continue to apply the lessons which have been learned during the war period in radio, radar, high-frequency heating, improved lighting, and use of power. Electronic controls and other improvements in power applications will do much to increase production with a decrease in labor. In fact, in this field we can expect engineers to continue the trend of increasing the power used per worker to make further advances in the American standard of living, thereby giving us more comforts with the same labor.

For the home and for the farm, new, improved, and more efficient appliances must be developed and marketed, and much work is to be done in providing adequate and attractive lighting. Labor saving and comfort in the home are as important as labor saving in the industry.

Last but not least in this world that is becoming more and more affected by technological developments, we as engineers must learn to increase the application of our analytical abilities to the fields of management, and in this direction lie many opportunities.

There is an open door ahead, and I believe there is a renewed opportunity for a long and useful career for engineers in the electric-power industry when peace comes.

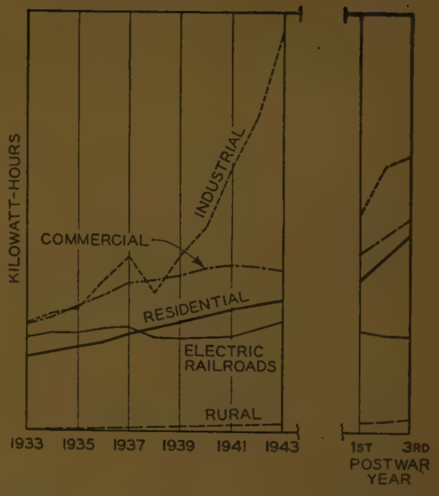

Figure 8. Past sales and predicted future sales to customer classes in Commonwealth Edison group of companies

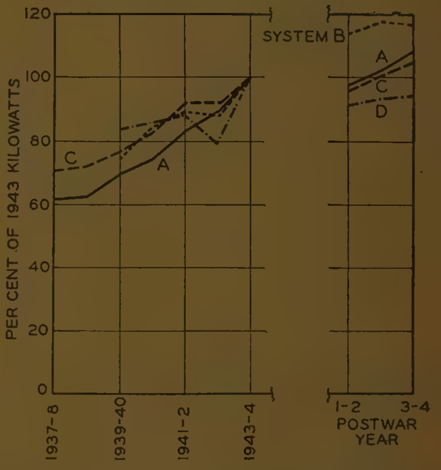

Figure 9. Past system peak loads and predicted future peak loads of Commonwealth Edison group

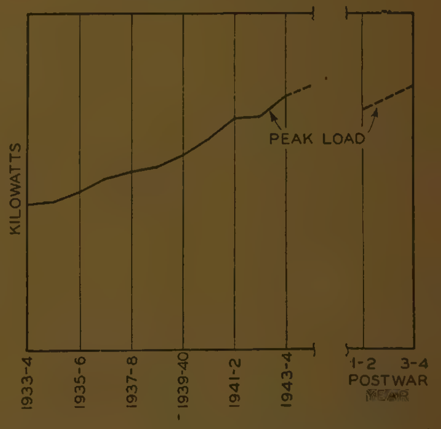

Figure 10. Past peak loads and predicted future peak loads of typical systems in relation to 1943 loads

INSTITUTE ACTIVITIES

Expanded Meeting Programs Require Publication Changes

The 1944 AIEE summer and Los Angeles meeting programs, which were greatly expanded to meet current wartime needs, have made available for publication during the second half of 1944 many more technical papers than originally were anticipated. In an effort to provide for publication of this material in an appropriate manner under present conditions, certain changes in publication procedure have been adopted.

Under present Governmental restrictions on the use of "magazine" paper, it is estimated that less than half of the total pages of the summer and Los Angeles technical meeting papers can be published in the monthly Transactions sections of *Electrical Engineering*, as compared with about three quarters in previous recent years. The Institute's quota of "book" paper, however, will enable all approved technical papers and discussions presented during the year to be published in the 1944 *Transactions* volume, as usual.

An appeal to the War Production Board for an additional allotment of magazine paper to publish more of these papers in the monthly Transactions sections brought only a token increase. A subsequent reappeal for a larger quantity was denied.

To make somewhat more efficient use of present paper tonnage, further economies are being effected. Beginning in the August issue, a three-column format with smaller type was adopted for the feature-article section. Effective with this issue, the spacing between lines in the Transactions section has been reduced. In addition, a lighter-weight paper will be used as soon as the present supply is exhausted.

With these new economies, in addition to those adopted earlier (*EE Jan '44 pp 24–5*), it is expected that all summer and Los Angeles technical meeting papers not exceeding six pages in length can be included in the Transactions sections of the remaining 1944 issues, as stipulated by the Institute's current publication policy. However, this will leave many more papers for publication in the "Supplement to Electrical Engineering—Transactions Section" than had been anticipated.

Because of the large amount of material that cannot be published in the monthly Transactions sections, two supplements will be issued for the second half of 1944 instead of the customary one. The first will contain the longer papers presented at the North Eastern District meeting, Boston, Mass., April 19–20, and at the summer technical meeting, St. Louis, Mo., June 26–30, plus all approved discussions of all papers presented at these two meetings. The second supplement will include the longer Los Angeles meeting papers and all approved discussions of all Los Angeles meeting papers. The first supplement will be issued as soon as the material involved can be released and prepared for publication; the second as soon after the close of the year as possible.

As announced periodically, the supplements are produced in a limited edition on an advance-order basis at 50 cents per copy. Further details as to the contents of these two supplements will be announced later.

Future AIEE Meetings

Winter Technical Meeting
New York, N. Y., January 22–26, 1945

North Eastern District Meeting
Buffalo, N. Y., Spring 1945

Summer Technical Meeting
Detroit, Mich., June 25–29, 1945

Lamme Medal Nominations

Attention is called again to the opportunity open to any Institute member to submit nominations for the 1944 AIEE Lamme Medal. All nominations must be received not later than December 1. For further particulars see *Electrical Engineering*, June 1944, page 225.

The 1943 medal was awarded to Arthur H. Kehoe, vice-president of the Consolidated Edison Company of New York, Inc., New York, N. Y. Addresses delivered at the presentation ceremonies are published in this issue of *Electrical Engineering*, pages 327–30.

PERSONAL ● ● ● ●

E. T. Augustine (A '27, M '33) formerly district engineer in the western division of the Western Massachusetts Electric Company, Pittsfield, has been appointed assistant chief engineer of the company with his office in Springfield, Mass. Mr. Augustine was graduated from the Thomas S. Clarkson Memorial College of Technology in 1924 with the degree of bachelor of science in electrical engineering. He received the degree of master of science in electrical engineering in 1926 and the professional degree of electrical engineer in 1928. Mr. Augustine became associated with the Western Massachusetts Company, Springfield, Mass. as system planning engineer in 1929. In 1932, he was transferred to Pittsfield as district engineer for the Pittsfield Electric Company, which later became the western division of the Western Massachusetts Electric Company.

G. H. Stickney (A '04, F '24) retired consulting illuminating engineer of the General Electric Company has been awarded the Illuminating Engineering Society Gold Medal in recognition of "meritorious achievement which has conspicuously furthered the profession, art, or knowledge of illuminating engineering." Mr. Stickney was assistant commercial engineer in the General Electric Company, Lynn (Mass.) works, from 1898 to 1909. He was employed in the company's Schenectady (N. Y.) works until 1911 when he was transferred to the Edison lamp works, Harrison, N. J. From 1930 to 1937 he was consulting engineer for the Nela Park engineering division, Cleveland, Ohio. He retired in 1937 to Daytona Beach, Fla.

H. B. Gear (A '01, F '20) vice-president in charge of operating and engineering, Commonwealth Edison Company, Chicago, Ill., retired recently. Born in Marietta, Ohio, March 6, 1872, Mr. Gear received the degree of bachelor of arts from Marietta College in 1892 and the degree of mechanical engineer from Cornell University in 1895. He joined the Commonwealth Edison Company in 1895 as an electrical inspector and he was engineer of distribution from 1911 to 1921. From 1921 to 1936 he was assistant to the vice-president in charge of engineering, construction, and operation. Mr. Gear was elected vice-president in 1936.

G. L. Harvey (Enrolled Student) engineer, Kellex Engineering Corporation, Oak Ridge, Tenn., has been awarded the 1943 District 6 prize award for Branch paper as coauthor of the paper, "A Two-Speed A-C Generator." Mr. Harvey was born in Denver, Colo., October 18, 1922. He received the degree of bachelor of science in electrical engineering from the University of Denver in 1943, and in that year he was chairman of the university's AIEE Student Branch. In 1943 he was employed as a test engineer by the General Electric Company, Denver, and was placed on leave of absence in 1944 to work with the Kellex Engineering Corporation.

F. T. Hague (A '14) formerly manager of engineering, steam division, Westinghouse Electric and Manufacturing Company, Lester, Pa., has been appointed assistant to the vice-president. Mr. Hague will serve as engineering consultant for all departments of the division. He has been with the company since his graduation from the University of Pittsburgh in 1911 with the degree of bachelor of science in electrical engineering.

M. H. Hobbs (M '37) formerly manager, switchboard engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been appointed manager of the engineering department of the division. Mr. Hobbs has been employed by the Westinghouse Company since 1922. He was a section engineer in the metal-clad switchgear section from 1925 to 1936 and was promoted to manager of switchboard engineering in 1936.

F. E. Bodine (A '43) formerly manager, Salt Lake City (Utah) office, Westinghouse Electric and Manufacturing Company, has been made manager of the company's San Francisco, Calif., office. Mr. Bodine has been in the employ of the Westinghouse Company since his graduation with the degree of bachelor of science in electrical engineering from Colorado State College in 1926.

OBITUARY

William Charles Louttit (M '31) assistant works manager, plastics division, Canadian Industries, Ltd., Brownsburg, Que., Canada, died July 9, 1944. Mr. Louttit, who was born in Kirkwall, Orkney, Scotland, July 17, 1895, received the degree of bachelor of science in electrical engineering from McGill University in 1921. He was employed as tester by the Imperial Wire and Cable Company, Montreal, Que., Canada, in 1912 and 1913. In 1913 he was employed by Mackenzie Mann and Company, on work for the Canadian National Railways, Montreal, as a battery charger and repairman. He left the company in 1915 to become affiliated with the Steel Company of Canada, Montreal, as a machine hand, but he returned to Mackenzie Mann and Company in 1916 as electrician. In 1920 he was employed as electrician in the Northern Electric Company, Montreal. He was employed by the Industrial Electric Company, Havana, Cuba, as electrical engineer from 1921 to 1922. In 1922 he became associated with the Havana Central Railroad, now known as the United Railways of Havana, as office engineer. He was made assistant chief electrical engineer in 1927 and became chief electrical engineer in 1928. Mr. Louttit received a commission in World War I and was a pilot in the Royal Air Force.

William J. Mowbray (A '03, M '12, F '31) instructor in electrical engineering, Rhode Island State College, Kingston, died July 4, 1944. Mr. Mowbray was born February 7, 1876, in Drumholm, Ireland. He was employed by the Edison Electric Illuminating Company of Brooklyn (N. Y.) from 1893 until 1905. In 1906, he became associated with the Narragansett Electric Lighting Company of Providence, R. I., and was in charge of distribution. From 1911 to 1918 he was in charge of the electrical laboratory. He was research and test engineer as well as educational director for the company from 1919 to 1930. During his employment, he invented the Mowbray test meter which is used for testing watt-hour meters. In 1932 he joined the faculty of Rhode Island State College. Mr. Mowbray was a member of the AIEE instruments and measurements committee from 1924 to 1929, and he served as a member of the executive committee from 1927 to 1932. He was the author of a number of technical papers.

Robert David Price (A '44) associate engineer, Newark (N. J.) Signal Corps inspection zone, died June 24, 1944. Born in Brooklyn, N. Y., March 6, 1917, Mr. Price was graduated from Polytechnic Institute of Brooklyn with the degree of bachelor of electrical engineering in 1938. He was employed by the Public Service Electric and Gas Company of New Jersey, Newark, as a cable inspector in 1937. In 1938 he was employed as an engineer for the Department of Public Works, New York, N. Y., and John A. Roebling's Sons Company, Trenton, N. J. From 1939 to 1940 he was associated with the American Transformer Company, Newark, N. J., as a test engineer. He was an inspector with the Navy Department, office of inspector of naval materials, Schenectady, N. Y., from 1940 to 1941. He had been employed as an associate engineer in the Newark Signal Corps inspection zone since 1941.

Douglas A. Elliott (A '28) lieutenant commander, United States Naval Reserve, died July 31, 1944. Commander Elliott was born June 14, 1893, in New York, N. Y. He was graduated from Princeton University with the degree of bachelor of literature in 1915 and received his electrical engineering degree from Columbia University in 1928. He was employed by the Electrical Research Products, Inc., New York, as district service supervisor in 1929. In 1931 he became installation planning supervisor for the company. He later joined the communications department of the Radio Corporation of America, New York. In 1942 he received his commission as lieutenant commander in the United States Naval Reserve and became naval advisor to the War Production Board, New York. He was transferred to Rochester, N. Y., in the same capacity in 1943. In 1944 he was made field officer for the industry cooperation division, Syracuse, N. Y.

Charles Ernest Cansfield (A '25) president, Cansfield Electrical Works, Ltd., Toronto, Ont., Canada, died July 23, 1944. He was born December 6, 1884, in York, England. From 1901 to 1906 he was employed by the North Eastern Railroad, York, as an apprentice electrical engineer. In 1906 he joined the York City Corporation as a junior engineer. He became a meter tester in the employ of the Toronto Electric Light Company in 1908. From 1919 to 1921 he was associated with the Toronto and Niagara Power Company as a relay engineer. He founded the Cansfield Electrical Works in 1921.

MEMBERSHIP

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the national secretary before September 30, 1944, or November 30, 1944, if the applicant resides outside of the United States or Canada.

To Grade of Member

Blumberg, R. D., Consulting Engr., Houston, Texas
Caswell, B. H., Sangamo Weston, Ltd., Wolverhampton, England
Coon, I. F. (Reelection), Commonwealth Edison Co., Chicago, Ill.
Elsey, H. M., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Formhals, W. H. (Reelection), Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Gray, K. (Reelection), Ward Leonard Elec. Co., Chicago, Ill.
Hooker, T., Delaware Pr. & Lt. Co., Wilmington, Del.
Jordan, C. E., H. A. Kuljian & Co., Philadelphia, Pa.
Knoeppel, F. W. (Reelection), U. S. Naval Air Station, Richmond, Fla.
Larson, R. W., Radio Corp. of America, Lancaster, Pa.
Lee, J. H., Ohio Midland Lt. & Pr. Co., Canal Winchester, Ohio
MacLean, W. R., Polytechnic Inst. of Brooklyn, Brooklyn, N. Y.
Manuele, J., Jr. (Reelection), Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Mock, R. M., Lear, Inc., Piqua, Ohio
Pennybacker, M. W., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Pierson, F., Stafford, Davies & Gogerty, Inyokern, Calif.
Renne, H. S., "Radio News & Radio-Electronic Engg.," Chicago, Ill.
Richardson, C. L. (Reelection), Captain, R.C.C.S., Toronto, Ont., Can.
Sama, C. M., Dharampur State, Bombay, India
Sparling, W. S., Ohio Bell Tel. Co., Cleveland, Ohio
Wortman, H. H., S.W. Bell Tel. Co., Oklahoma City, Okla.

21 to grade of Member

To Grade of Associate

United States and Canada

1. NORTH EASTERN

Chermak, R. M., Gen. Elec. Co., Schenectady, N. Y.
Hart, R. D., Univ. of Conn., Storrs, Conn.
Hubert, E. F., J. J. Costello Co., Boston, Mass.
Sauer, A. W., Bethlehem Steel Corp., Lackawanna, N. Y.

2. MIDDLE EASTERN

Gibson, D. L., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Moore, L. B., Grimes Mfg. Co., Urbana, Ohio
Muszynski, S., Duquesne Light Co., Pittsburgh, Pa.
Richardson, D. C., Celanese Corp. of America, Cumberland, Md.
Sherrard, J. O., National Elec. Coil Co., Columbus, Ohio
Turner, E. R., Trumbull Elec. Mfg. Co., Norwood, Ohio
Vaughan, J. T., Ohio Crankshaft Co., Cleveland, Ohio
Weil, C., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Williams, R. B., Gen. Elec. Co., Baltimore, Md.

3. NEW YORK CITY

Coleman, H. S., Gen. Cable Corp., Perth Amboy, N. J.
Esteve, C. A., El Indicador Industrial, New York, N. Y.
Gillespie, C. N., R.C.A. Laboratories, New York, N. Y.
Goertz, R. C., Sperry Gyroscope Co., Garden City, N. Y.
Henderickson, H. S., Sperry Gyroscope Co., Inc., Garden City, N. Y.
Tinsley, W. E., Sperry Gyroscope Co., Inc., Great Neck, N. Y.
Weiner, J. R., R.C.A. Laboratories, New York, N. Y.

4. SOUTHERN

Cogburn, C. W., Florida Pr. & Lt. Co., Fort Pierce, Fla.
Duncan, W. E., Tenn. Valley Auth., Chattanooga, Tenn.

5. GREAT LAKES

Arnold, W. C., Central Ill. Light Co., Princeville, Ill.
Cartwright, P. A., Univ. of Minn., Minneapolis, Minn.
Frank, C. W., Automatic Elec. Co., Chicago, Ill.
Grabbe, G. M., Gen. Motors Corp., Indianapolis, Ind.
Hunter, O. L., Chicago Bridge & Iron Co., Seneca, Ill.
Jackson, B., USAAF Matériel Command, Minneapolis, Minn.
Jones, C. L., Kinney Elec. Mfg. Co., Chicago, Ill.
Kauppi, T. A., Dow Corning Corp., Midland, Mich.
Klenze, R. O. (Reelection), Acme Steel Co., Chicago, Ill.
Langford, M. H., Dow Magnesium Corp., Marysville, Mich.
Nelson, C. O., Radio Corp. of America, Indianapolis, Ind.
Stanback, H. I., Jr., Square D Co., Milwaukee, Wis.
Timerman, A. T., Schweitzer & Conrad, Inc., Chicago, Ill.

7. SOUTH WEST

Brooks, F. E., Jr., Univ. of Texas, Austin, Texas
Peterson, F. W., St. Louis Shipbuilding & Steel Co., St. Louis, Mo.
Walsh, C. H., Arkansas Pr. & Lt. Co., Pine Bluff, Ark.

8. PACIFIC

Ansell, R. J., U. S. Navy, San Francisco, Calif.
Begovich, N. A., Calif. Inst. of Tech., Pasadena, Calif.
Dinapoli, D. P. (Reelection), Pacific Gas & Elec. Co., San Francisco, Calif.
Hassell, P. A., Chief Radio Technician, U. S. Navy, San Francisco, Calif.
Kahn, L. P., Douglas Aircraft Co., Inc., Long Beach, Calif.
McClure, J. L., Allis-Chalmers Mfg. Co., San Francisco, Calif.
Reimers, J. M., Marinship Corp., Sausalito, Calif.
Ryall, E. W., Douglas Aircraft Co., Inc., Santa Monica, Calif.
Simonoff, A. A., Moore Dry Dock Co., Oakland, Calif.
Wissbaum, J. D., Bethlehem Steel Co., San Francisco, Calif.

9. NORTH WEST

Cook, R. A., D. C. Griffin, Seattle, Wash.
Macdonald, R., Montana Pr. Co., Great Falls, Mont.

Elsewhere

Jauge, L., Rio Negro Hydroelec. Dev., Montevideo, Urug., S. A.
Saenz de Camara, M., Gen. Elec., S. A., Mexico, Mex.
Watson, H. L., Central Illawarra Shire, Unanderra, N. S. W., Aust.
Gulati, K. B. N., Jind State, Sangrur, India
Mehl-Blum, D. W., Emp. de Tele. Ericsson, S. A., Mexico, Mex.
Lippincott, M., Rio de Janeiro Tram., Lt. & Pr. Co., Ltd., Rio de Janeiro, Brasil, S. A.

Total to grade of Associate
United States and Canada 50
Elsewhere 6

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(Term expires July 31, 1945)

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(Term expires July 31, 1945)

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(Term expires July 31, 1946)

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6	L. A. BINGHAM	Boulder, Colo.
[illegible]	J. M. GAYLORD	Los Angeles, Calif.
10	W. J. GILSON	Toronto, Ontario

(Terms expire July 31, 1945)

1	R. T. HENRY	Buffalo, N. Y.
3	J. F. FAIRMAN	New York, N. Y.
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7	R. W. WARNER	Austin, Tex.
9	C. B. CARPENTER	Portland, Ore.

(Terms expire July 31, 1946)

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(Terms expire July 31, 1945)

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W. B. MORTON	Philadelphia, Pa.
W. R. SMITH	Newark, N. J.

(Terms expire July 31, 1946)

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C. W. MIER	Dallas, Tex.
S. H. MORTENSEN	Milwaukee, Wis.

(Terms expire July 31, 1947)

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M. J. McHENRY	Toronto, Ontario
D. A. QUARLES	New York, N. Y.

(Terms expire July 31, 1948)

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W. I. SLICHTER	New York, N. Y.

(Term expires July 31, 1945)

National Secretary

H. H. HENLINE	New York, N. Y.

(Term expires July 31, 1945)

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Brazil—Richard H. Bowles, Sao Paulo Tramway Light and Power Company, Sao Paulo

England—A. P. M. Fleming, Metropolitan-Vickers Electric Company, Trafford Park, Manchester

France—A. S. Garfield, 45 Bd. Beausejour, Paris, 16E

India, Northern—V. F. Critchley, 11 Bahawalpur Road, Lahore, Punjab

India, Southern—N. N. Iengar, The Tata Power Co. Ltd., Bombay House, Bruce Street, Fort Bombay

New Zealand—P. H. Powell, Canterbury College, Christchurch

Sweden—A. F. Enstrom, Ingeniorsvetenskrapsakademien, Stockholm 5

Transvaal, South Africa—W. Elsdon-Dew, P.O. Box 4563, Johannesburg

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(Terms expire July 31, 1949)

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(Terms expire July 31, 1945)

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(Terms expire July 31, 1946)

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(Terms expire July 31, 1947)

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Charles Concordia
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L. O. Grondahl
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C. N. Clark
W. E. Crawford
G. H. Fett
C. J. Firth
G. W. Garman
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(*Continued on next page*)

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District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities
1 North Eastern	R. T. Henry, 303 Electric Bldg., Buffalo, N. Y.	Victor Siegfried, Worcester Polytechnic Institute, Worcester, Mass.	R. G. Porter, Northeastern University, Boston, Mass.
2 Middle Eastern	W. E. Wickenden, Case School of Applied Science, Cleveland 6, Ohio	H. R. Vaughan, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.	P. X. Rice, Pennsylvania State College, State College, Pa.
3 New York City	J. F. Fairman, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York 3, N. Y.	C. S. Purnell, Westinghouse Elec. & Mfg. Co., 40 Wall St., New York 5, N. Y.	D. H. Wright, Pratt Institute, Brooklyn, N. Y.
4 Southern	C. W. Ricker, Tulane University, New Orleans, La.	F. E. Johnson, Jr., 317 Baronne St., New Orleans 9, La.	W. O. Leffell, University of Tennessee, Knoxville, Tenn.
5 Great Lakes	M. S. Coover, Iowa State College, Ames, Iowa	N. C. Pearcy, Public Utility Engg. & Service Corp., 231 S. LaSalle St., Chicago 4, Ill.	M. M. Cory, Michigan State College, East Lansing, Mich.
6 North Central	L. A. Bingham, University of Colorado, Boulder, Colo.	Platt Wicks, University of Colorado, Boulder, Colo.	O. E. Edison, University of Nebraska, Lincoln, Nebr.
7 South West	R. W. Warner, University of Texas, Austin, Tex.	S. R. Friedsam, 3612 Bonnie Road, Austin, Tex.	M. C. Hughes, A. & M. College of Texas, College Station, Tex.
8 Pacific	J. M. Gaylord, Metropolitan Water District of Southern California, 306 W. Third St., Los Angeles 13, Calif.	Mark A. Sawyer, Box 5300, Metropolitan Station, Los Angeles, Calif.	F. W. Maxstadt, California Institute of Technology, Pasadena, Calif.
9 North West	C. B. Carpenter, Pacific Tel. & Tel. Co., 730 S.E. Oak St., Portland, Ore.	C. C. Bozier, Westinghouse Elec. & Mfg. Co., 309 S.W. Sixth Ave., Portland 4, Ore.	L. D. Harris, University of Utah, Salt Lake City, Utah
10 Canada	Walter J. Gilson, 1244 Dufferin St., Toronto, Ont.	W. Roy Harmer, H.E.P.C. of Ontario, 620 University Ave., Toronto, Ont.	

Each District executive committee includes also the chairmen and secretaries of all Sections within the District, and the District vice-chairman of the national membership committee.

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Parker & Aaron, 55 Liberty Street, New York 5, N. Y.

Student Branches of the Institute

Name and Location	District	Counselor (Member of Faculty)
Akron, Univ. of, Akron, Ohio	2	A. J. B. Fairburn
Alabama Polytechnic Inst., Auburn	4	
Alabama, Univ. of, University	4	W. J. Miller
Alberta, Univ. of, Edmonton, Can	10	R. E. Phillips
Arizona, Univ. of, Tucson	8	J. C. Clark
Arkansas, Univ. of, Fayetteville	7	W. B. Stelzner
British Columbia, Univ. of, Vancouver, Can.	10	W. B. Coulthard
Brooklyn, Polytechnic Inst. of, Brooklyn, N. Y	3	A. B. Giordano
Brown Univ., Providence, R. I.	1	F. N. Tompkins
Bucknell Univ., Lewisburg, Pa.	2	K. B. MacKichan
Calif. Inst. of Tech., Pasadena	8	F. W. Maxstadt
Calif., Univ. of, Berkeley	8	P. L. Morton
Carnegie Inst. of Tech., Pittsburgh, Pa.	2	G. R. Patterson
Case School of Applied Science, Cleveland, Ohio	2	P. L. Hoover
Catholic Univ. of America, Washington, D. C.	2	T. J. MacKavanagh
Cincinnati, Univ. of, Cincinnati, Ohio	2	
Clarkson College of Technology, Potsdam, N. Y.	1	A. R. Powers
Clemson Agricultural College, Clemson, S. C.	4	F. T. Tingley
Colorado State Col. of A. & M. Arts, Fort Collins	6	F. B. Beatty
Colorado, Univ. of, Boulder	6	H. B. Palmer
Columbia Univ., New York, N. Y.	3	J. R. Ragazzini
Connecticut, Univ. of, Storrs	1	P. H. Nelson
Cooper Union, New York, N. Y.	3	E. E. Shelton
Cornell Univ., Ithaca, N. Y.	1	E. T. B. Gross
Delaware, Univ. of, Newark, Del.	2	M. G. Young
Denver, Univ. of, Denver, Colo.	6	F. H. McClain
Detroit, Univ. of, Detroit, Mich.	5	H. O. Warner
Drexel Inst. of Technology, Philadelphia, Pa.	2	E. O. Lange
Duke Univ., Durham, N. C.	4	Otto Meier, Jr.
Florida, Univ. of, Gainesville	4	E. F. Smith
George Washington Univ., Washington, D. C.	2	
Georgia School of Technology, Atlanta	4	H. B. Duling
Harvard Univ., Cambridge, Mass.	1	J. D. Cobine
Idaho, Univ. of, Moscow	9	J. Hugo Johnson
Illinois Inst. of Technology, Chicago	5	E. H. Freeman
Illinois, Univ. of, Urbana	5	E. A. Reid
Iowa State Col., Ames	5	B. S. Willis
Iowa, Univ. of, Iowa City	5	H. R. Reed
Johns Hopkins Univ., Baltimore, Md.	2	M. W. Pullen
Kansas State Col., Manhattan	7	R. G. Kloeffler
Kansas, Univ. of, Lawrence	7	G. A. Richardson
Kentucky, Univ. of, Lexington	4	Brinkley Barnett
Lafayette Col., Easton, Pa.	2	F. W. Smith
Lehigh Univ., Bethlehem, Pa.	2	C. G. Brennecke
Louisiana State Univ., Baton Rouge	4	A. K. Ramsey
Louisville, Univ. of, Louisville, Ky.	4	S. T. Fife
Maine, Univ. of, Orono	1	W. J. Creamer
Manhattan Col., New York, N. Y.	3	R. T. Weil
Marquette Univ., Milwaukee, Wis.	5	J. F. H. Douglas
Maryland, Univ. of, College Park	2	L. J. Hodgins
Mass. Inst. of Technology, Cambridge 39	1	K. L. Wildes
Michigan Col. of Mining & Tech., Houghton	5	G. W. Swenson
Michigan State Col., East Lansing	5	M. M. Cory
Michigan, Univ. of, Ann Arbor	5	J. S. Gault
Milwaukee School of Engg., Milwaukee, Wis.	5	E. L. Wiedner
Minnesota, Univ. of, Minneapolis	5	J. H. Kuhlmann
Mississippi State Col., State College	4	L. L. Patterson
Missouri School of Mines & Met., Rolla	7	F. H. Frame
Missouri, Univ. of, Columbia	7	M. P. Weinbach
Montana State Col., Bozeman	9	E. W. Schilling
Nebraska, Univ. of, Lincoln	6	O. E. Edison
Nevada, Univ. of, Reno	8	S. G. Palmer
Newark Col. of Engineering, Newark, N. J.	3	S. Fishman
New Hampshire, Univ. of, Durham	1	W. B. Nulsen
New Mexico State Col., State College	7	M. A. Thomas
New Mexico, Univ. of, Albuquerque	7	R. W. Tapy
New York, Col. of the City of, New York	3	Harry Baum
New York Univ., New York	3	P. C. Cromwell
North Carolina State Col., Raleigh	4	L. M. Keever
North Dakota State Col., Fargo	5	H. S. Rush
North Dakota, Univ. of, Grand Forks	5	C. W. Rook
Northeastern Univ., Boston, Mass.	1	R. G. Porter
Northwestern Univ., Evanston, Ill.	5	R. W. Jones
Norwich Univ., Northfield, Vt.	1	F. A. Spencer
Notre Dame, Univ. of, Notre Dame, Ind.	5	J. A. Northcott
Ohio Northern Univ., Ada	2	G. W. Klein
Ohio State Univ., Columbus	2	S. O. Evans
Ohio Univ., Athens	2	W. M. Young
Oklahoma A. & M. College, Stillwater	7	A. Naeter
Oklahoma, Univ. of, Norman	7	R. A. Church
Oregon State Col., Corvallis	9	A. L. Albert
Pennsylvania State Col., State College	2	P. X. Rice
Pennsylvania, Univ. of, Philadelphia	2	S. R. Warren, Jr.
Pittsburgh, Univ. of, Pittsburgh, Pa.	2	R. C. Gorham
Pratt Institute, Brooklyn, N. Y.	3	D. H. Wright
Princeton Univ., Princeton, N. J.	2	W. C. Johnson
Puerto Rico, Univ. of, Mayaguez, P. R.	3	M. Wiewall, Jr.
Purdue Univ., Lafayette, Ind.	5	R. B. Marshall
Rensselaer Polytechnic Inst., Troy, N. Y.	1	E. D. Broadwell
Rhode Island State Col., Kingston	1	W. J. Mowbray
Rice Inst., Houston, Tex.	7	C. R. Wischmeyer
Rose Polytechnic Inst., Terre Haute, Ind.	5	C. C. Knipmeyer
Rutgers Univ., New Brunswick, N. J.	3	J. L. Potter
Santa Clara, Univ. of, Santa Clara, Calif.	8	W. J. Warren
South Carolina, Univ. of, Columbia	4	W. M. Bauer
South Dakota State College, Brookings	5	W. H. Gamble
South Dakota State School of Mines, Rapid City	6	E. E. Clark
Southern California, Univ. of, Los Angeles, Calif.	8	P. S. Biegler
Southern Methodist Univ., Dallas, Tex.	7	E. H. Flath
Stanford Univ., Stanford University, Calif.	8	H. H. Skilling
Stevens Inst. of Technology, Hoboken, N. J.	3	W. L. Sullivan
Swarthmore Col., Swarthmore, Pa.	2	
Syracuse Univ., Syracuse, N. Y.	1	C. W. Henderson
Tennessee, Univ. of, Knoxville	4	W. O. Leffell
Texas A. & M. Col., College Station	7	M. C. Hughes
Texas Technological Col., Lubbock	7	C. V. Bullen
Texas, Univ. of, Austin	7	A. W. Straiton
Tufts College, Tufts College, Mass.	1	A. H. Howell
Tulane Univ., New Orleans 15, La.	4	M. G. Zervigon
Union Col., Schenectady 5, N. Y.	1	H. W. Bibber
Utah, Univ. of, Salt Lake City	9	O. C. Haycock
Vanderbilt Univ., Nashville, Tenn.	4	S. R. Schealer
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Virginia Military Inst., Lexington	4	J. S. Jamison
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Washington, State College of, Pullman	9	H. F. Lickey
Washington, Univ. of, Seattle	9	R. E. Lindblom
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West Virginia Univ., Morgantown	2	A. H. Forman
Wisconsin, Univ. of, Madison	5	G. F. Tracy
Worcester Polytechnic Inst., Worcester, Mass.	1	V. Siegfried
Wyoming, Univ. of, Laramie	6	R. O. Trueblood
Yale Univ., New Haven, Conn.	1	A. G. Conrad
Total Branches 125		

Local Sections of the Institute

Name	District	When Organized	Membership Aug. 1, 1944	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	104	A. G. Seifried	P. S. Bechtol	1359 Ottawa Ave., Akron 5, Ohio
Alabama	4	May 22, '29	44	F. G. Hamner	T. E. Curtis	Southern States Equipment Corp., 28 S. 20th St., Birmingham 3, Ala.
Arizona	8	Mar. 22, '41	50	C. R. Smith	E. A. Gissel	Central Arizona Light & Power Co., Phoenix, Ariz.
Boston	1	Feb. 13, '03	604	A. L. O'Banion	R. E. Muehlig	Westinghouse Elec. & Mfg. Co., 235 Old Colony Ave., Boston, Mass.
Central Indiana	5	Jan. 12, '12	148	C. E. Parks		
Chicago	5	1893	869	R. C. Ericson	J. F. Calvert	Northwestern Technological Institute, Evanston, Ill.
Cincinnati	2	June 30, '20	149	A. J. Allen	G. W. Coulehan	607 Chamber of Commerce Bldg., Cincinnati 2, Ohio
Cleveland	2	Sept. 27, '07	390	W. R. Hough	J. D. Leitch	The Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio
Columbus	2	Mar. 17, '22	84	R. W. Miner	E. M. Boone	Dept. of Elec. Engg., Ohio State University, Columbus, Ohio
Connecticut	1	Apr. 16, '21	363	Carl F. Scott	C. D. Hewitt	P.O. Box 1562, New Haven 6, Conn.
Dayton	2	June 9, '43	173	J. W. Gehrke	F. S. Himebrook	Master Electric Co., Dayton, Ohio
Denver	6	May 18, '15	192	Hubert Sharp	L. R. Patterson	Public Service Co. of Colorado, Denver, Colo.
East Tennessee	4	Sept. 2, '36	206	J. D. Harper	F. A. Hoeke	General Electric Co., 602 S. Gay St., Knoxville, Tenn.
Erie	2	Jan. 11, '18	74	J. Hause	W. C. Brown	General Electric Co., Erie, Pa.
Florida	4	Jan. 28, '31	134	C. F. Titus	P. J. Carlin	Florida Power & Light Co., Miami, Fla.
Fort Wayne	5	Aug. 14, '08	107	W. W. Brooks	S. A. Zimmermann	2600 Hoagland Ave., Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	115	T. J. Woth	R. O. Loomis	Georgia Power Co., Atlanta 1, Ga.
Houston	7	Aug. 7, '28	180	Hezzie Clark	R. S. Kersh	612 Petroleum Bldg., Houston 2, Texas
Iowa	5	June 29, '29	78	E. B. Fowler	H. R. Reed	State University of Iowa, Iowa City, Iowa
Ithaca	1	Oct. 15, '02	65	E. M. Strong	H. G. Smith	Cornell University, School of Elec. Engg., Ithaca, N. Y.
Kansas City	7	Apr. 14, '16	146	M. E. Bretschneider	P. C. Cross	General Electric Co., 106 W. 14th St., Kansas City 6, Mo.
Lehigh Valley	2	Apr. 16, '21	179	H. E. Pearson	J. A. G. Oewel	Penn. Pwr. & Lt. Co., 901 Hamilton St., Allentown, Pa.
Los Angeles	8	May 19, '08	635	P. L. Johnson	E. W. Morris	Westinghouse Elec. & Mfg. Co., 420 So. San Pedro St., Los Angeles 13, Calif
Louisville	4	Oct. 15, '26	75	M. S. Winstandley	S. H. Gates	So. Bell Tel. & Tel. Co., 521 W. Chestnut St., Louisville 2, Ky.
Lynn	1	Aug. 22, '11	211	M. S. Wilson	R. G. Connors	788 Broad St., Lynn, Mass.
Madison	5	Jan. 8, '09	75	F. D. Mackie	G. F. Tracy	Elec. Lab., University of Wisconsin, Madison 5, Wis.
Mansfield	2	Mar. 6, '39	65	J. M. Robinson	H. G. Duhamel	North Electric Mfg. Co., Galion, Ohio
Maryland	2	Dec. 16, '04	381	B. Van Ness, Jr.	H. H. Angel	Bethlehem Steel Co., Sparrows Point, Md.
Memphis	4	May 22, '30	72	T. H. Allen	J. A. Crisman	Westinghouse Elec. & Mfg. Co., 825 Exchange Bldg., Memphis 1, Tenn.
Mexico	3	June 29, '22	83	F. A. Nava	F. Aubert	Apartado Postal 1399, Mexico, D.F. Mexico
Michigan	5	Jan. 13, '11	404	M. M. Cory	L. W. Clark	Detroit Edison Co., 2000—2nd Ave., Detroit 26, Mich.
Milwaukee	5	Feb. 11, '10	371	T. B. Jochem	J. W. Pomazal	Louis Allis Co., 427 E. Stewart St., Milwaukee 4, Wis.
Minnesota	5	Apr. 7, '02	124	C. W. Lethert	F. W. Hotchkiss	Electric Machine Mfg. Co., Minneapolis, Minn.
Montana	9	June 24, '31	36	I. J. Buergey	W. R. Neumann	Montana Power Company, Great Falls, Mont.
Montreal	10	Apr. 16, '43	208	F. L. Lawton	J. R. Auld	Canadian Industries Ltd., Engg. Dept., Montreal, P.Q., Canada
Muscle Shoals	4	Feb. 18, '38	22	Leo King	Arthur Vaughn	702 Commons, Tuscumbia, Ala.
Nebraska	6	Jan. 21, '25	51	Donald Thomas	I. M. Ellestad	Northwestern Bell Telephone Co., Omaha, Nebr.
New Mexico–West Texas	7	Mar. 7, '40	54	R. C. Dickson	J. F. Armstrong	3219 Altura Blvd., El Paso, Tex.
New Orleans	4	Dec. 8, '33	151	B. H. Bell	L. J. Olivier	Louisiana Pwr. & Lt. Co., New Orleans 14, La.
New York	3	Dec. 10, '19	3,814	M. D. Hooven	W. S. Hill	General Electric Co., 570 Lexington Ave., New York 22, N. Y.
Niagara Frontier	1	Feb. 10, '25	185	W. K. Parks	W. J. Freudenberger	Buffalo Niagara Elec. Corp., 300 Electric Bldg., Buffalo 3, N. Y.
North Carolina	4	Mar. 21, '29	119	H. B. Robinson	L. M. Keever	North Carolina State College, Raleigh, N. C.
North Texas	7	May 18, '28	177	E. H. Flath	R. W. Roessler	1007 Insurance Bldg., Dallas, Tex.
Oklahoma City	7	Feb. 16, '22	100	C. L. Farrar	C. L. Jobe	Oklahoma Gas & Electric Co., Oklahoma City 2, Okla.
Philadelphia	2	Feb. 18, '03	892	A. C. Muir	M. L. Lehman	American Tel. & Tel. Co., 530 Bourse Bldg., Philadelphia 6, Pa.
Pittsburgh	2	Oct. 13, '02	663	R. C. Gorham	C. M. Skooglund	West Penn Power Co., 14 Wood St., Pittsburgh 30, Pa.
Pittsfield	1	Mar. 25, '04	196	J. L. Cantwell	T. E. Rodhouse	General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.
Portland	9	May 18, '09	189	W. E. Enns	O. A. Demuth	Box 3537, Portland 12, Ore.
Providence	1	Mar. 12, '20	101	R. E. Secord	G. E. Andrews	The Narragansett Elec. Co., 49 Westminster St., Providence, R. I.
Rochester	1	Oct. 9, '14	124	O. L. Angevine, Jr.	E. B. Kempster	General Motors Corp., Rochester 3, N. Y.
St. Louis	7	Jan. 14, '03	320	C. M. Lovell	Ray Robson	Union Electric Co. of Missouri, Webster Groves, Mo.
San Diego	8	Jan. 18, '39	74	W. J. Kenline	C. F. McCabe	Consolidated Aircraft Corp., Lindbergh Field, San Diego, Calif.
San Francisco	8	Dec. 23, '04	682	G. C. Tenney	A. Tilles	Dept. of Elec. Engg., Univ. of California, Berkeley, Calif.
Schenectady	1	Jan. 26, '03	619	L. A. Umansky	L. T. Rader	General Electric Co., Industrial Control Engg. Dept., Schenectady, N. Y.
Seattle	9	Jan. 19, '04	274	C. H. Cutter	H. R. Brown	2136—47th Ave., S.W., Seattle 6, Wash.
Sharon	2	Dec. 11, '25	135	F. D. Fielder	A. D. Forbes	Westinghouse Elec. & Mfg. Co., Sharon, Pa.
South Bend	5	Feb. 26, '41	60	C. M. Dunn	C. D. Highleyman	Indiana & Michigan Elec. Co., So. Bend, Ind.
South Carolina	4	Mar. 2, '40	47	W. H. Kendrick	F. T. Tingley	Clemson College, Clemson, S. C.
South Texas	7	May 23, '30	48	I. A. Uhr	O. T. Lodal	1411 Smith Young Tower, San Antonio, Tex.
Spokane	9	Feb. 14, '13	103	R. C. Kelly	G. H. Sargeant	Aluminum Co. of America, Box 6116, Hillyard Sta., Spokane 14, Wash.
Springfield	1	June 29, '22	55	L. P. Kongsted	W. S. Scheering	Western Massachusetts Cos., 73 State St., Springfield 2, Mass.
Syracuse	1	Aug. 12, '20	126	J. W. Dice	C. E. von Sothen	General Electric Co., 113 S. Salina St., Syracuse, N. Y.
Toledo	2	June 3, '07	87	R. L. Manor	W. M. Campbell	2145 Central Grove Ave., Toledo, Ohio
Toronto	10	Sept. 30, '03	381	A. W. Murdock	J. F. Moore	Dunlop Wire & Rubber Goods Ltd., 870 Queen St. E., Toronto, Canada
Tulsa	7	Oct. 1, '37	73	H. A. Norberg	E. F. Patterson	General Electric Co., 405 Mid-Continent Bldg., Tulsa, Okla.
Urbana	5	Nov. 25, '02	87	E. A. Reid	P. F. Schwarzlose	212 Elec. Engg. Lab., University of Illinois, Urbana, Ill.
Utah	9	Mar. 9, '17	79	E. Bachman	J. A. McDonald	General Elec. Co., P.O. Box 779, Salt Lake City 9, Utah
Vancouver	10	Aug. 22, '11	101	L. B. Stacey	G. K. Haspel	1992 West 41st Ave., Vancouver, B. C., Canada
Virginia	4	May 19, '22	147	C. E. Creecy	A. F. Forbes	Newport News Shipbuilding & Drydock Co., Newport News, Va.
Washington	2	Apr. 9, '03	707	W. F. Dietz	H. M. Bollinger	Chesapeake & Potomac Tel. Co., 1111 N. Capitol St., Washington 2, D. C.
West Virginia	2	Apr. 9, '40	39	L. W. Roush	E. B. Ellerbe	Box 911, Charleston 23, W. Va.
Wichita	7	Sept. 16, '37	74	E. H. Stephens	H. E. Hartman	Kansas Gas & Elec. Co., 201 N. Market St., Wichita 1, Kansas
Worcester	1	Feb. 18, '20	65	V. F. P. Sepavich	R. M. Peirce	American Steel & Wire Co., Electrical Cable Works, Worcester, Mass.
Total Sections	73		18,415			

Local Subsections

Name	Chairman	Secretary	Secretary's Address
Beaumont (Houston Section)	L. H. Matthes	G. W. Morgan	P.O. Box 2951, Beaumont, Tex.
Hamilton (Toronto Section)	H. W. Blackett	K. R. Knights	Canadian Westinghouse Co. Ltd., Hamilton, Ont., Canada
Illinois Valley (Urbana Section)	G. B. Smedley	F. A. Ericzon	Central Illinois Light Co., Peoria, Ill.
Niagara Falls (Niagara Frontier Section)	Edw. Bond, Jr.	F. A. Anderson	1021—90th St., Niagara Falls, N. Y.
Ottawa (Montreal Section)	B. G. Ballard	J. H. Simpson	National Research Council, Ottawa, Ont., Canada
Rock River Valley (Madison Section)	C. V. Bullen	B. T. Anderson	625 Rome Ave., Rockford, Ill.
Wilmington (Philadelphia Section)	K. Pinder	Henry Evans	Delaware Pwr. & Lt. Co., 600 Market St., Wilmington, Del.
Zanesville (Columbus Section)	J. H. Ludden	J. G. Tankovich	Line Material Co., Zanesville, Ohio

OF CURRENT INTEREST

Adapter Plug Provides Mobility for Field Switchboards

A new light compact telephone switching unit developed by the Signal Corps, Army Service Forces, is supplanting for emergency field service the bulky switchboards hitherto used. This unit, the Adapter Plug *U–4/GT*, can be used for terminating a local battery telephone line, and several plugs, used with a field telephone for the operator's set, will provide a workable switchboard substitute which may be set up rapidly.

Weighing only one ounce, the plug can be transported to many spots inaccessible to a battery switchboard. It also is moisture-proof which makes it invaluable for jungle or mountain operations, for beach landing in rain-drenched areas, and for air-borne operations behind the enemy lines. The transparent plastic body of the plug contains fasteners for line connections, a neon lamp that responds to ringing signals, and two combination jacks and plugs for tandem connections between adapter plugs. The resistance and neon lamp are inside the plastic body which makes them virtually impervious to moisture and fungus attacks. A luminescent identification plate on which the operator may enscribe the line number is embedded in the plastic.

The plug builds up a flexible switchboard upon which the operator can make not only individual connections but also conference connections by calling individually the parties desired and connecting the adapter plugs in tandem.

The *U–4/GT* was developed in response to an elementary need, realized especially in the Pacific war theater, of substituting a visual signal for the bell signal. The latter could be heard from considerable distances by enemy snipers. Extension of the use of the plugs to the building of substitute emergency switchboards was a by-product. The visual signal functions when the operator attaches the field-wire pair entering his outpost to an adapter plug and connects his telephone by a short length of field wire to another adapter plug. Incoming calls flash the lamp in the first plug.

Packaged Carrier Facilitates Work of Signal Corps

A "packaged carrier," which enables non-technical men with only a rudimentary knowledge of communications work to set up field units and to operate them with complete success, is a partial explanation of how the Plant Engineering Agency of the Signal Corps' Army Communications Service, an organization of only 1,400 officers and enlisted men, has been able to erect over 400 large-sized installations for the Army since October 1943.

The packaged carrier is a prefabricated kit of communications equipment, so simple as to be almost foolproof, accompanied by clear and specific instructions. By using the kit, a number of messages can be sent simultaneously, both by voice and telegraph, upon two open telephone wires. The messages are unscrambled at the receiving end.

The Plant Engineering Agency functions on a world-wide scale and is responsible for installing and maintaining all fixed communications of the Army, among which meteorological stations and air base radio stations are especially numerous. The Agency crews often work under enemy fire as well as under natural disadvantages in setting up field radio stations. For example, when coral atolls selected for invasion have been too small to hold their equipment, it sometimes has been necessary to land the receiving and transmitting equipment on adjacent islands separated by vulnerable open channels. Through the work of the Agency, field headquarters in every theater of war can communicate instantly with the commanding general and with the War Department in Washington, D. C. Agency headquarters are in Philadelphia, Pa., under the command of Colonel Will V. Parker.

Radio Outfitting of B-29 Bomber Is Signal Corps Achievement

When the Army Air Forces *B*-29 Superfortress takes off on a bombing mission, it carries 2,000 pounds of Signal Corps aircraft radio equipment. This load is nearly double the amount normally carried by the Flying Fortress, the Liberator, and other heavy bombers.

The radio sets installed range from one-half pound to 550 pounds in weight and provide for communication between aircraft in flight, between the bombers and their distant bases, and between crew members within the airplane. Navigational devices allow the pilot to fly a direct or diverse course, to locate bases precisely on his return, and to execute safe landings. Devices to guide rescuers to a forced landing at sea also are included. No new equipment was designed for the Superfortress, but selection from the types available was made on the basis of performance on long-range flights.

According to Colonel Hobart R. Yeager, commanding officer of the Signal Corps Aircraft Signal Agency, the radio complement for the superbomber was the largest single installation job ever undertaken by the Signal Corps laboratory at Wright Field. Technical problems encountered by the laboratory were numerous, Colonel Yeager said, because of the great number of different types of radio equipment which had to be made to operate without neutralizing each other. The altitude range of the bomber and the construction design also raised problems.

Officers and civilian engineers of Aircraft Radio Laboratory have been engaged on the *B*-29 project since it was first launched by the AAF. Early in 1940 the laboratory prepared specifications and other data relative to radio requirements which were incorporated in the first experimental model. Late in 1943 engineering personnel of the laboratory completed the first installation of radio equipment in a production model.

Army and Navy Co-operation Speeds up Specification Routines

Reports indicate that over 1,500 qualification approvals have been co-ordinated between the Signal Corps and the Bureau of Ships as a result of the program, inaugurated about 18 months ago, of standardization of Army and Navy specifications for communication equipment.

Army–Navy co-ordination of standards has been facilitated by two agencies: the Signal Corps Standards Agency, organized under a

The Superfortresses move two abreast through three 300-foot-wide assembly bays at the Boeing–Renton plant constructed by the Austin Company, engineers and builders. There is more than 1,000,000 square feet of these 300-foot clear-span areas in the three Boeing plants now producing the United States's heaviest bomber

joint agreement between Lieutenant General Brehon Somervell and Vice-Admiral Samuel Robinson, and the Army–Navy Electronics Standard Agency. Both are in Red Bank, N. J.

Under the new time-saving program, the qualification tests for each type of equipment are made by only one agency and the data forwarded to other interested agencies as a basis for approvals. Plastics, for example, are tested by the Bureau of Ships and dry batteries by the Signal Corps. Specifications on the materials tested are being compiled as joint Army–Navy Standards and will be used by all of the services of the Army and all the bureaus of the Navy. Joint inspection of equipment and co-ordination of waivers similarly are replacing former duplication. When, as happened with vacuum tubes and radio-frequency cables, the routine procedures of the Signal Corps Standards Agency and ANESA have been found insufficient, special groups or subcommittees are set up.

INDUSTRY . . . . .

NAM Advises Training Foremen to Readjust Veterans to Industry

The special training of foremen for their part in the rehabilitation of veterans into industry recently was called the foremost objective of management's responsibility in rehabilitating the veterans in a report of the committee on supervisory relations of the National Association of Manufacturers.

Preparatory guidance and information which will enable the foreman to develop the right attitude toward the problem and a better understanding of how to deal soundly with veterans can be given through intelligent foreman conferences, special bulletins, and other mediums, according to the committee. Specifically, the committee recommended that management provide supervisory personnel with some training and information on these points:

1. The employer's legal obligations embodied in section 8 of the Selective Service Law, particularly the provisions related to the veteran's rights to his former job.
2. The effect of section 8 on the seniority practices of industry generally and the particular company's stated and contractual seniority practices.
3. The GI Bill of Rights, its provisions, and the various benefits it grants veterans.
4. The company's veteran employment program, as it variously concerns veterans who were former employees, veterans who were not prewar employees but have had experience in similar work, and veterans who are being employed for the first time and need indoctrination into industry.
5. Human and technical problems involving the foreman's friendly understanding of the fact that the veteran is eager to succeed on the job and the fact that it is the foreman's duty to see that the veteran is given the full benefit of assistance from both the personnel and medical departments in order to fit smoothly into his working life.
6. The physically handicapped need proper placement and, when fitted into the right job and properly trained, they are wholly productive. Veterans still undergoing medical treatment need to have their time arranged so that they may continue any treatments necessary to bring them back to normal health.

Committee members from the electrical industry include: T. O. Armstrong, manager industrial relations, Westinghouse Electric and Manufacturing Company, Springfield, Mass.; R. C. Cosgrove, vice-president and general manager, the Crosley Corporation, Cincinnati, Ohio; H. H. Kerr (M '26) general superintendent, the Toledo Edison Company, Toledo, Ohio; and H. J. Robertson, Jr., president, the Fibre Conduit Company, Orangeburg, N. Y.

Industrial Protection From X Rays Studied by ASA

Initiation of a new project to develop and standardize means of protection from X-ray burns in industry has been announced by the American Standards Association. The X ray recently has become a prominent method of inspection in meeting the rigid requirements for metal castings, welding, and the like in war industries. Its use has increased about 2,000 per cent in the past two years, and few, if any, city or state safety codes insure protection from X-ray radiation for operators or others working near X-ray machines. The project which was undertaken at the request of the Department of Labor will be carried on under the American War Standard procedure of the association.

The portable type of machine which can direct rays at any angle presents a particularly difficult safety problem, according to the ASA announcement. With the greater number of workers necessarily new and inexperienced and often without benefit of adequate instruction, the use of this equipment may cause grave injury. Unfortunately, some of the most serious effects of overexposure to X rays may not be detected for years. Symptoms of the more usual maladies, skin cancer, anemia, sterilization, and cataract are slow in developing.

New Magazine for Latin America Issued. A new bimonthly technical magazine, *El Ingeniero Westinghouse*, printed in Spanish and made up of articles from recent issues of *Westinghouse Engineer*, plus additional engineering information for readers in Central and South America, makes its initial appearance this month, according to announcement from John W. White, president and general manager of the Westinghouse Electric International Company. The new publication will be dedicated to increased co-operation among the Americas, and is designed to keep its readers informed on vital developments in Latin America.

RMA Announces Formation of Two New Committees

Formation of two new committees, the Radio Technical Planning Board television reporting committee and the school sound systems committee, is announced by Radio Manufacturers' Association.

The RTPB television reporting committee under the chairmanship of Ray H. Manson (M '18) of Rochester, N. Y., will review the forthcoming report of RTPB television panel 6 and prepare official RMA views on the development and promotion of television. The School Sound systems committee, headed by Chairman L. A. King of St. Charles, Ill., will develop specifications and promote public-address equipment in schools and similar institutions and will co-operate with the board of education and committees of the Federal Communications Commission and other industry groups on school apparatus.

Three RMA committees have been discontinued: the postwar planning committee, the legislative committee, and the replacement parts committee. Functions of the disbanded committees have been taken over by other still existing committees of RMA.

EDUCATION . . .

Acoustical Research Instituted at Rutgers University

Organization of the division of acoustical research in the college of engineering for the purpose of investigating air-borne sounds, has been announced by Rutgers University, New Brunswick, N. J. The work of the division will be carried on under contract with the Office of Scientific Research and Development and will be directed by Carl F. Eyring, professor of physics, Brigham Young University, Salt Lake City, Utah. Other members of the staff are: Arthur A. Allen, professor of ornithology, Cornell University, Ithaca, N. Y.; Wayne B. Hales, professor of physics, Brigham Young University; James L. Potter (A '41) professor of electrical engineering, Rutgers University; Peter P. Kellogg, assistant professor of ornithology, Cornell University; Obed C. Haycock (M '39) associate professor of electrical engineering, University of Utah, Salt Lake City; William L. Nastuk, assistant in physiology, Rutgers University; Anthony J. Del Mastro, instructor in civil engineering, Rutgers University.

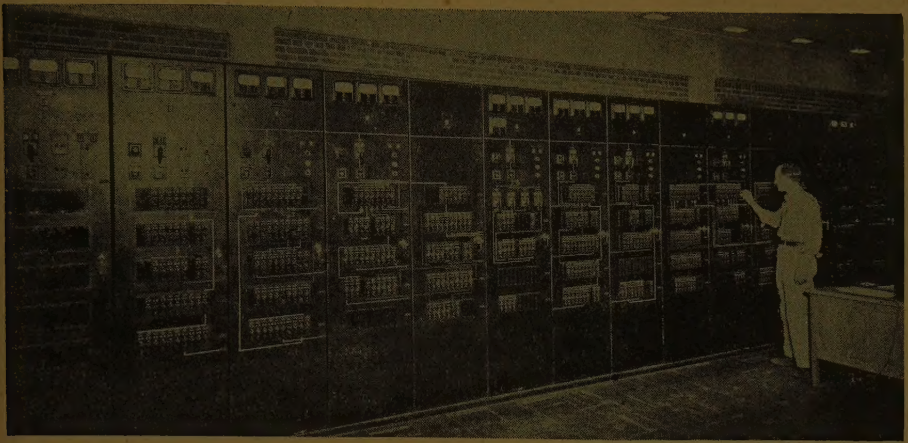
Colleges Prepare for Admission Problems of Veterans

As the end of the war approaches the problem of establishing equitable and educationally sound policies for granting college credit to the returning veterans who have had specialzied training or who have studied either independently or under the direction of the Armed Forces Institute while in military service confronts the colleges and universities with greater immediacy.

To aid institutions seeking advice, the committee on accrediting procedures of the American Council on Education has made a thorough study of the problem and reviewed the findings and suggestions of representative college-admission officers, registrars, and deans who have surveyed the operations of the Armed Forces Institute. By its recommendations the committee hopes to counteract any trend toward lowering educational standards because of pressure from interested groups including legislative bodies or from the competition for students existing among some colleges.

Pointing out that the commanding officers in charge of the Army's schools are not authorized to recommend to educational institutions the amount of credit that should

New Switchboard for Western Steel Mill



Westinghouse Photo

This supervisory control board in the switch house at the Geneva Steel Company, a subsidiary of the United States Steel Corporation, controls and supervises more than 500 points of switching and apparatus control in all distribution substations and motor rooms throughout the entire plant

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be allowed for the various training programs under their jurisdiction, the committee made the following recommendations for evaluating military educational experience:

1. For technical and vocational training gained in the services, credit should be given only if the fields correspond to subjects for which the institutions regularly grant credit.

2. If a member of the Armed Forces believes that he has mastered the content of a course accredited by an institution, he should have the opportunity to demonstrate his eligibility for such credit in an examination compiled either by the institution or the Armed Forces Institute.

3. Credit for specialized training courses carried on by regular university staffs for the Armed Forces should be allowed in accordance with an institution's regular policies. A transcript containing a detailed description of the courses should be issued for transfer to another institution.

4. For Army Specialized Training Program and Navy *V*-12 courses, the transcript should be accompanied by a statement of the courses' equivalent in terms of those regularly offered to civilians.

5. A member of the Armed Forces who demonstrates his competence in an approved examination should be considered for admission to college.

6. Upon satisfactory completion of correspondence courses given by a recognized college or university in co-operation with the Armed Forces Institute, credit should be allowed a student on the basis of the policies adopted by the individual institution.

7. Credit should be officially recorded by the college only for students who have been or are under instruction by that institution. This is not to be construed, however, as limiting the college in advising students regarding their probable classification in the institution.

Also pertinent to the colleges' problem is the preparation by the Armed Forces of a standard form reporting military experience which has a bearing on school and college credit. This form which includes data on training experiences, off-duty education, and individual educational activities will be available to all branches of the Armed Forces.

Upon the committee's recommendation the accrediting and educational associations have contributed substantial sums for the financial support of a staff whose present activities are:

1. Preparation of a "Guide to the Evaluation of Educational Experiences in the Armed Services" for distribution to schools and colleges. This handbook describes the formal training programs of the armed services and recommends for each program the base upon which credit should be awarded.

2. Assistance to higher education institutions and secondary schools on policies for interpreting examination reports and records of military service provided by the Armed Forces Institute or by the several branches of the Armed Forces.

3. Collection of information from educational institutions regarding their policies with reference to credit for educational experience gained in the armed services.

4. Assistance to higher institutions and secondary schools at their request in developing procedures to put into operation the general policies recommended by the committee on accrediting procedures of the American Council on Education.

Inquiries for further information concerning these services and orders for the guide which is two dollars per copy, should be addressed to G. P. Tuttle, 363 Administration Building, Urbana, Ill.

OTHER SOCIETIES •

American Co-ordinating Committee on Corrosion Elects Officers

Frank L. LaQue of the development and research division of International Nickel Company was elected chairman of the American Co-ordinating Committee on Corrosion at its sixth annual meeting held recently. George H. Young of the Mellon Institute of Industrial Research was named vice-chairman, and George W. Seagren, also of the Mellon Institute was elected secretary-treasurer.

The Co-ordinating Committee, organized in 1938, serves as a clearing house and co-ordinating agency for information on American experience and American work in progress in the field of corrosion and corrosion prevention, and acts as an agency for the exchange of corrosion information and experience with similar foreign agencies such as the corrosion committee of the British Iron and Steel Institute. The Committee is composed of official delegates from the following societies: American Foundrymen's Association, American Gas Association, American Institute of Chemical Engineers, AIEE, American Society of Mechanical Engineers, American Society for Metals, American Society of Refrigerating Engineers, American Society for Testing Materials, American Water Works Association, Armour Research Foundation, Battelle Memorial Institute, The Electrochemical Society, Mellon Institute of Industrial Research, National Bureau of Standards, National District Heating Association, National Research Council, Society of Automotive Engineers.

Six subcommittees have been active in the past several years, co-ordinating studies on underwater paints, co-operating with the British Admiralty Marine Corrosion Committee, examining and approving applications for grants-in-aid from the research fund offered by the American Society for Metals for the support of fundamental research on corrosion, standardizing corrosion test materials and terms and symbols, and advising the Navy's Bureau of Ships on special problems on request.

ASTM Officers Announced

American Society for Testing Materials announces its new officers, elected at its annual meeting held recently. They are:

President: P. H. Bates, chief, clay and silicate products division, National Bureau of Standards, Washington, D. C.

Vice-president: Arthur W. Carpenter, manager, testing laboratories, The B. F. Goodrich Company, Akron, Ohio.

Members of the executive committee: W. C. Hanna, chief chemist and chemical engineer, California Portland Cement Company, Colton, Calif.; L. B. Jones, engineer of tests, test department, The Pennsylvania Railroad Company, Altoona, Pa.; J. T. MacKenzie, chief metallurgist, American Cast Iron Pipe Company, Birmingham, Ala.; J. G. Morrow, chief metallurgist, The Steel Company of Canada, Ltd., Hamilton, Canada; Sam Tour, president, Sam Tour and Company, Inc., New York, N. Y.

Elected to honorary membership were the following authorities in the field of engineering materials:

Rudolph Philip Miller, consulting engineer, New York City, dean of building-code experts, and authority on construction, fire tests of materials; Milton Earl McDonnell, former chief chemist, Pennsylvania Railroad Company; and Hermann Von Schrenk, consulting timber engineer for many of the country's railroad systems and authority on wood and timber—its procurement and utilization, prevention of disease, and decay.

Standard for Terminal Markings Revised by ASA and NEMA

The fourth edition of the "American Standard for Terminal Markings for Electrical Apparatus *C*6.1–1944" has been completed under the sponsorship of the National Electrical Manufacturers Association and approved by the American Standards Association.

The Standard covers the following apparatus: a-c and d-c generators, single-phase and other capacitor motors, power and distribution transformers, feeder voltage regulators, electric water heaters, attachment plugs and receptacles, industrial control, instrument transformers, and current-limiting reactors.

The sections dealing with markings for instrument transformers and reactors have

Future Meetings of Other Societies

American Association for the Advancement of Science. Annual meeting, September 11–16, 1944, Cleveland, Ohio.

American Chemical Society. 108th annual meeting, September 11–15, 1944, New York, N. Y.

American Society of Mechanical Engineers. Fall meeting, October 2–5, 1944, Cincinnati, Ohio; annual meeting, November 27–December 1, 1944, New York, N. Y.

American Welding Society. Annual meeting, October 16–19, 1944, Cleveland, Ohio.

Association of Iron and Steel Engineers. Annual meeting, September 25–27, 1944, Pittsburgh, Pa.

Edison Electric Institute. Accident prevention committee, September 12–13, 1944, New York, N. Y.; prime movers committee, October 2–3, 1944, Pittsburgh, Pa.; electrical equipment committee, October 5–6, 1944, Pittsburgh; transmission and distribution committee, October 9–10, 1944, Buffalo, N. Y.

Electrochemical Society. Fall meeting, October 12–14, 1944, Buffalo, N. Y.

Electronic Parts and Equipment Industry Conference. October 19–21, 1944, Chicago, Ill.

Engineers' Council for Professional Development. Annual meeting, October 20, 1944, New York, N. Y.

Illuminating Engineering Society. Annual convention, September 14–16, 1944, Chicago, Ill.

Institute of the Aeronautical Sciences. Air transport meeting, September 1944, Washington, D. C.; fall meeting, November 1944, Dayton, Ohio.

National Electrical Contractors Association. Annual meeting, October 1–5, 1944, French Lick, Ind.

National Electrical Manufacturers Association. October 23–27, 1944, New York, N. Y.

National Electronics Conference. October 5–7, 1944, Chicago, Ill.

National Industrial Chemical Conference and Third National Chemical Exposition. November 15–19, 1944, Chicago, Ill.

National Safety Congress of the National Safety Council. October 3–5, 1944, Chicago, Ill.

Society of Motion Picture Engineers. 56th semiannual fall conference, October 16–18, 1944, New York, N. Y.

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been enlarged and the material co-ordinated with similar provisions in the American Standard for Transformers *C*57. An entirely new section on electric water heaters has been added. For the first time color is employed as a means of identification in the wiring of electric water heaters and associated devices. The "American Standard Terminal Markings for Electrical Apparatus *C*6.1–1944" may be obtained from the American Standards Association, 29 West 39th Street at $1 per copy.

Canadian Electrical Code in Process of Revision

Consideration now is being given to a general revision of the Canadian Electrical Code, part I, preparatory to publication of a fifth edition. Subcommittees organized to review the various sections of the code now are engaged in the work of revision.

Any and all proposals for revision will be welcome and should be submitted without delay in order that fullest consideration may be given them well in advance of the closing date for receipt of proposals. All such proposals should, if possible, be in the form of the actual text desired for incorporation into the fifth edition.

The closing date for receipt of proposals for revision is October 1, 1944. Requests for revision received after that date may be held for the next general revision. This notice is directed particularly to electrical interests in Canada and to electrical manufacturers in Great Britain and the United States who export electrical equipment and appliances to Canada. Proposals should be addressed to: The Secretary, Canadian Standards Association, National Research Building, Ottawa, Ont., Canada.

British Standard on Telecommunication. The "Glossary of Terms Used in Telecommunication," published in Great Britain in 1943 by the British Standards Institution and received recently by the American Standards Association library covers essentially the same subject matter as the sections on electrocommunication and electronics of the "American Standard Definitions of Electrical Terms, *C*42–1941." The British Standard, however, includes more terms than the American Standard. The terms "klystron" and "rhumbatron" are defined in the British glossary for the first time in any official standards publication.

Standard for Dial Indicators Issued. A new Commercial Standard for Dial Indicators, *CS*(*E*) 119–45, has been accepted by the National Bureau of Standards and will become effective for new production January 1, 1945. The purpose of the commercial standard for which acceptances have been received from manufacturers, distributors, and users, is to provide minimum essential requirements for precision dial indicators as a basis for a better understanding between sellers and buyers, for fair competition, and for purposes of identification of precision dial indicators.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

The Engineering Degree

To the Editor:

Mr. Gould's comments on the various types of engineering degree (*EE, June '44, p. 278–9*) are worthy of action by the various scientific societies.

It is difficult to change existing practice but the right thing to do would be to revamp the requirements and authorization for granting a degree. You could have one degree used for honorary issuance, then limit the highest degree granted for college work to a masters degree, then have all higher degrees first approved by a joint scientific societies committee.

The promiscuous and professionally uncontrolled requirements for granting a degree is cheapening the scientific profession. All the scientific societies should set up jointly a schedule of performance requirements that permits a tangible scoring of measurable accomplishments.

The individual scientific society could set up requirements which are measured by a tangible scoring of accomplishments in the particular field of the society. The scoring should be more liberal in order to place it within reach of young engineers in a reasonable time and thereby maintain and stimulate his interest and pride in his profession and technical society.

The name of the degrees probably would have to be coined by the joint scientific societies committee because of existing names for degrees. For example, doctor of science would be the proper title for the main scientific degree, but there are many doctor of science degrees in existence which would not meet the more rigid requirements.

The one basic requirement for any degree scoring would be a bachelors degree in some science. Then the scoring for the main degree would be along these lines with (8) a requirement:

1. College masters degree = 1 point.
2. College doctors degree = 2 points.
3. College instructor of a science subject = 1/3 point per year, 10 points maximum.
4. Issued patent = 1 point for one invention, 10 points maximum.
5. Published technical paper approved by a scientific society for a degree count = 1 point for one paper, 10 points maximum.
6. Member of a scientific society = 1 point total.
7. Three recommendations from degree men in two scientific societies = 1 point.
8. Degree from a scientific society = 1 point total.

Possession of 12 points would permit an application to be filed with the joint scientific societies committee for approval and issuance of the degree or issuance by a college.

Scoring of intangible services must be avoided since we want to give recognition to the professional man who by personal effort has contributed something tangible and direct to his profession, the public, and industry.

Too much is expected of young men with their doctor's degree, and young men with a doctor's degree resent being supervised by a man with a bachelor's degree. So let us lift the profession to a higher plane by setting up degree requirements which compel universal acceptance and honor.

CARL G. JONES (A'16, M'18)

(Special engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio)

Industrial Research Under Free Enterprise

To the Editor:

It seems to me that *Electrical Engineering* is lowering itself and inviting disunity amongst the membership by allowing itself to become a medium for political controversy. I refer specifically to the article by Mr. Ruthenberg in the June issue in which he refers to "political meddling, restriction, and persecution of American business" and "a remarkable river named the Tennessee which runs through Tennessee but drains all 48 states." I think you will agree that the latter statement would be extremely distasteful to a TVA member of AIEE and would cause him to wonder why he was contributing to such an attack upon his own organization.

The statement that the Institute assumes no responsibility for the expressions of contributors theoretically makes everything all right, but practically it does not.

In the interests of unity, I respectfully suggest that you disallow the insertion of controversial political statements in articles unless the membership as a body takes a stand on the questions involved.

DONALD G. WORTH (A '32, M '40)

(Senior electrical engineer, Bonneville Power Administration, Washington, D. C.)

To the Editor:

Mr. Louis Ruthenberg, whose address appears in the June 1944 issue of *Electrical Engineering*, pages 210–15, entitled, "Industrial Research Under Free Enterprise," cites eminent authority as to the tremendous savings made by inventions.

Doctor Pupin is quoted as stating that certain of his inventions saved the public $100,000,000, and other instances might be cited. For example, no one could begin to estimate the enormous savings made by the vacuum tube of Doctor Lee De Forest. Doctor Pupin points out that he personally got only a microscopic part of this saving, and Doctor De Forest could say the same thing.

Mr. Ruthenberg has very well presented particular instances of a general law, which is that no inventer ever can receive from the general public more than the public thinks his invention is worth. The inventer makes a bargain with the Commissioner of Patents under which the inventer allows the Commissioner to publish the inventer's secret in return for a limited monopoly. The issue of the patent, however, does not insure in any way that the inventer ever will make any profit from his invention. For the inventer to get anything, embodiments of his invention must be sold to the public, and the public will not buy unless the invention is sold at a price that will enable the public to make a profit or saving from the use of the invention after paying the inventer his usually small stipend. It must be more profitable to the public to use the invention than to use anything that has gone before, and the inventer can collect profit from his invention only if and as long as the public profits from its use. He, however, can collect for only a limited period, and Doctor Pupin long ago ceased to collect anything from his valuable inventions, which are still in general use. Doctor Pupin and many other inventers have made perpetual gifts to civilization for short-lived and small rewards. Of course, we all realize that no inventer now can hope to receive a large award as he must reckon with surtaxes, which now start at about bare subsistence levels. We make ability in invention, just as we make business ability, a misdemeanor punishable by fines which are graduated so that the more ability a man has, the heavier the fine.

The fundamental equities of the patent system are so strong that it has come through a period of muddled public thinking without serious damage in spite of vicious attacks by the radical socialists who are at least fellow travellers with some people in high places.

The Kilgore Bill, to which Mr. Ruthenberg refers, is a good example of what the Socialists would do if they could, and it is quite significant that no one eminent in applied science has approved it. A geneticist, anthropologist, or astronomer may look with favor on Government subsidies and Government control, but no engineer as yet has shown any enthusiasm for a WPA for scientists and engineers.

There is a lull in the Socialist's program due to the war, but this program is dormant, not dead, and we can expect that it will be revived as soon as the stress of war diminishes. Mr. Ruthenberg's address is therefore well timed.

FORD W. HARRIS (A '06, F '13)

(Senior partner, Harris, Kiech, Foster, and Harris, Los Angeles, Calif.)

To the Editor:

Please consider this as my protest against the series of articles recently published concerning the Kilgore Bill. I consider the article by Louis Ruthenberg to be in bad taste. It lowers the standard of the publication.

If you are to avoid another outburst of the old accusation that the AIEE is run for and by a small coterie of men who are subservient to the National Electrical Manufacturers Association, you can do no less than grant space to a member who is sympathetic with the New Deal and labor so that suitable answer can be made.

If you officers at headquarters only could know the undercurrent of revolt which is active among the rank and file of the members, you would broaden the outlook of the publication.

ROY C. DWYER (A '39)

(Engineer, Aluminum Company of America, Riverbank, Calif.)

EDITOR'S NOTE. The feature article columns of *Electrical Engineering* are always open to significant material on any topic in its field or on closely related subjects. Rather than shun any subject because it is of a controversial nature, it has been the policy to publish material reflecting significant aspects of such controversial subjects as fall within the field.

PAMPHLETS • • •

Postwar Employment and the Liquidation of War Production. Committee for Economic Development, 285 Madison Avenue, New York 17, N. Y., 23 pages, no charge.

Fiscal and Monetary Policy. Beardsley Ruml and H. C. Sonne. National Planning Association, 800 21st Street, N. W., Washington 6, D. C., 41 pages, 25 cents.

Evaluating Apprentices. Apprentice-Training Service, Bureau of Training, War Manpower Commission, Washington, D. C., 20 pages, no charge.

Fleet-Welding. Lincoln Electric Company, Cleveland 1, Ohio, 48 pages.

Distribution—The Bottleneck to Farm Electrification. By Frank E. Watts. *The Farm Journal*, Washington Square, Philadelphia, Pa., 30 pages.

Nitrocellulose. Hercules Powder Company, Wilmington 99, Del., 54 pages.

A Summary of Data on Synthetic Rubber. The Rubber Manufacturers Association, 444 Madison Avenue, New York 22, N. Y., 36 pages.

Reproduction Manual. The Multi-Color Company, 629 Woodward Avenue, Detroit, Mich., unpaged, $5.

NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

Physical Chemistry of Electrolytic Solutions. (American Chemical Society Monograph Series 95.) By H. S. Harned and B. B. Owen. Reinhold Publishing Corporation, New York, N. Y., 1943. 611 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $10. (ESL.)

The first five chapters deal with general thermodynamics, the basic interionic attraction theory, and ionic solutions in equilibrium and in perturbed states. There is a numerical summary. The succeeding five chapters comprise a discussion of experimental methods for the study of electrolytes. The last five chapters cover the properties of electrolytes such as hydrochloric acid, 1–1, and polyvalent electrolytes, with the last two chapters considering, respectively, the strong and weak electrolytes.

Principles of Electrodeposition. By S. Field. Sir Isaac Pitman and Sons, London, England; Pitman Publishing Corporation, New York, N. Y., 1944. 314 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $6. (ESL.)

This volume provides a simple treatment of the principles of electrochemistry that are of interest to electroplaters and electrorefiners. The treatment is nonmathematical and emphasizes industrial and experimental viewpoints.

Public Rural Electrification. By F. W. Muller. American Council on Public Affairs, Washington, D. C., 1944. 183 pages, tables, 9 by 6 inches, paper, $2.50; cloth, $3. (ESL.)

This is a report on the development and present status of rural electrification in this country, with some attention to the future. The functions, organization, and general character of the Rural Electrification Administration and of local co-operative systems are discussed as well as their relationships in regard to control and planning.

Railway Fuel and Traveling Engineers' Association. Seventh annual proceedings, 1943. Railway Fuel and Traveling Engineers' Association, 327 South La Salle Street, Chicago 4, Ill. 206 pages, illustrated, $9^1/_4$ by 6 inches, cloth, $3. (ESL.)

The proceedings contain the reports of the officers and of various committees and discussions on gas-turbine locomotives, firing practice, Diesel locomotives, coal firing, and the utilization of motive power. There are also papers on efficiency and economy in steam-locomotive operation and on fast-freight braking.

Tables for Converting Rectangular to Polar Co-ordinates. By J. C. P. Miller. Dover Publications, New York. Reprint of 1939 publication, 16 pages, tables, $9^3/_4$ by 6 inches, paper, 75 cents. (ESL.)

These tables, which are intended for use with a calculating machine or slide rule, will be found useful by electrical engineers and others.

Tables of Lagrangian Interpolation Coefficients. Prepared by the mathematical tables project, Work Projects Administration of the Federal Works Agency; conducted under the sponsorship of the National Bureau of Standards. Published by Columbia University Press, New York, N. Y., 1944. 392 pages, tables, $10^3/_4$ by 8 inches, cloth, $5. (ESL.)

This volume extends the existing tables of Lagrangian interpolation coefficients in n-point polynomials for $n=3, 4, \ldots, 11$ by giving the entries at smaller intervals of the argument and by making adequate provision for interpolation near the beginning and near the end of the table. All the coefficients of Everett's central difference formula, as well as several other special types, are identical with certain Lagrangian coefficients given in this table. The main group consists of eight- to ten-place tables.

Abbrevs. (A dictionary of abbreviations.) Compiled by H. J. Stephenson. Macmillan Company, New York, N. Y., 1943. 126 pages, $8^1/_2$ by $5^1/_2$ inches, cloth, $1.75. (ESL.)

This dictionary brings together a great number of abbreviations commonly met in books and papers and frequently puzzling to the reader. Literary, scientific, and industrial fields are covered.

Life of Sir J. J. Thomson. By Lord Rayleigh. University Press, Cambridge, England; Macmillan Company, New York, N. Y., 1943. 299 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $6. (ESL.)

Lord Rayleigh has written an excellent account of the life of the great physicist, in which is reviewed the epoch-making scientific work done at the Cavendish Laboratory by Thomson and his pupils. The human side of the man also is covered. Laymen as well as scientists will find the book full of interest.

Mathematics of Radio Communications. By T. J. Wang. D. Van Nostrand Company, New York, N. Y., 1943. 371 pages, illustrated, 9 by $5^1/_2$ inches, fabrikoid, $3. (ESL.)

This textbook was written to facilitate the study of radio, electronics, and so forth, by providing a course in mathematics integrated with one in communications, the subjects being interwoven so that each electrical topic is preceded by the requisite mathematics. The book is designed especially for use in accelerated programs.

Quantitative Analysis. By H. S. Booth and V. R. Damerell. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1944. 303 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $2.50. (ESL.)

This elementary textbook covers the course of practical work usually given beginners and is adapted either for a half-year or a year course. The directions are clear and explicit.

Basic Radio. By C. L. Boltz. Ronald Press Company, New York, N. Y., 1944. 272 pages, illustrated, 8 by 5 inches, cloth, $2.25. (ESL.)

"Basic Radio" is based on the syllabus for British air training cadets, and forms an interesting contrast to the similar books published for use in the United States Army. It presents an elementary course in fundamentals and is exceptionally clear and simple.

Industrial Management. By A. S. Knowles and R. D. Thomson. The Macmillan Company, New York, N. Y., 1944. 791 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $4.50. (ESL.)

The subject matter of this book is confined to topics of immediate concern to persons who must direct the work of others in manufacturing enterprises. The six main divisions are: introduction; management of physical property; organization of the physical plant; management of man power; production control; and cost control. Such topics as time and motion study may appear under two or more headings if pertinent. Practical problems representing actual situations are included.

Fundamentals of Vibration Study. By R. G. Manley with a foreword by W. K. Wilson. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1942. 124 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $2.75. (ESL.)

Fundamental principles underlying present-day vibration study are presented in such a way as to be readily assimilated by the busy engineer. Major topics considered are the physics of the simple vibrating system, damping and forced vibration, systems with two or more degrees of freedom, and the application of Fourier's analysis to complex vibrations.

Fundamentals of Radio Communications. By A. R. Frey. Longmans, Green and Company, New York, N. Y., London, England, Toronto, Ont., 1944. 393 pages, illustrated, $8^1/_2$ by 6 inches, cloth, $4. (ESL.)

In this book an effort has been made to present the fundamentals of the subject as concisely as possible. In accordance with this desire, the aim has been to familiarize the student with the terminology of radio, with the more important types of circuits, and with the ways in which vacuum tubes can be used to generate, control, and detect the high-frequency currents that are used. References are supplied for further study of various subjects.

From a Chemist's Diary. (Kansas City Testing Laboratory Bulletin 29.) By R. Cross. Kansas City Testing Laboratory, Cross Laboratories, Kansas City, Mo., 1943. 315 pages, illustrated, 9 by 6 inches, cloth, $3. (ESL.)

This book is a collection of random items from the diary of the writer, a consulting industrial and research chemist. They have been selected for their interest for the person not specially trained in chemistry or science and technical details have been kept to a minimum. The wide range of topics covers meteorology, earthquakes, the patent system, and octimal arithmetic as well as sidelights on many applications of chemical analysis.

Technique of Motion Picture Production. Published for the Society of Motion Picture Engineers by Interscience Publishers, New York, N. Y., 1944. 150 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $3.50. (ESL.)

This volume contains 11 papers presented at a convention of the Society of Motion Picture Engineers. These papers describe current technical practice in motion-picture production, with production stages arranged in the order generally followed in producing and presenting motion pictures. The book combines much information that has not been accessible heretofore in a logical convenient form.

Theorie und Anwendung der Laplace-Transformation. By G. Doetsch. Dover Publications, New York, 16, N. Y., 1943. 439 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $3.75. (ESL.)

This reproduction of Doetsch's classic monograph makes it available in this country at a price very much below the original one. The book, first published in 1937, provides a comprehensive descriptive analysis of the theory and mathematical foundations of the Laplace transformation and its practical application to problems of physics and electrical engineering. A German–English glossary has been added to the reprint.

Diesel Locomotives. By J. Draney. American Technical Society, Chicago, Ill., 1944. 388 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $3.75. (ESL.)

A simple practical text on the operation and maintenance of the electrical equipment of Diesel locomotives. The equipment of the Baldwin-Westinghouse, Electro-Motive, and Alco-G.E. locomotives is described in detail.